The Journal of Bone and Joint Surgery

The Official Publication of
The American Orthopaedic Association
The British Orthopaedic Association
The American Academy of Orthopaedic Surgeons
The Australian Orthopaedic Association
The Canadian Orthopaedic Association
American Society for Surgery of the Hand
New Zealand Orthopaedic Association
South African Orthopaedic Association

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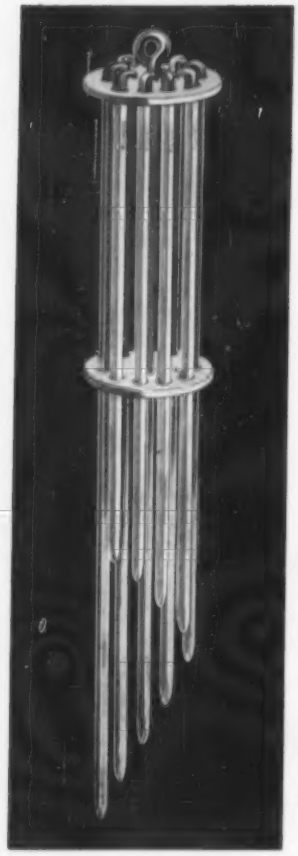

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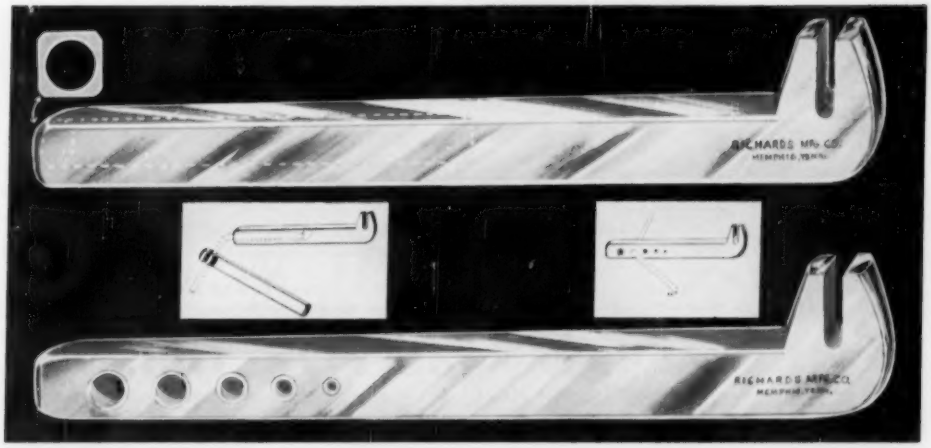

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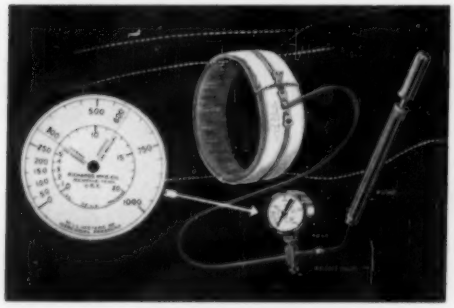

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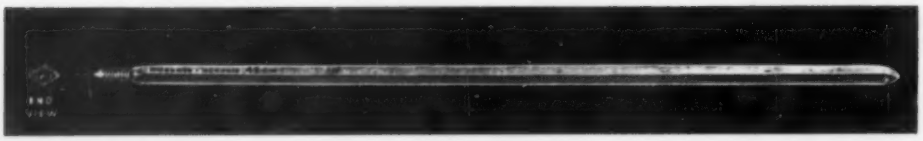

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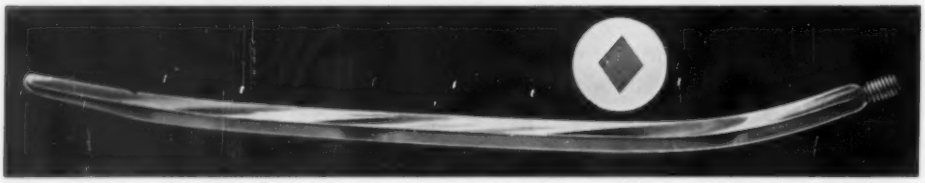

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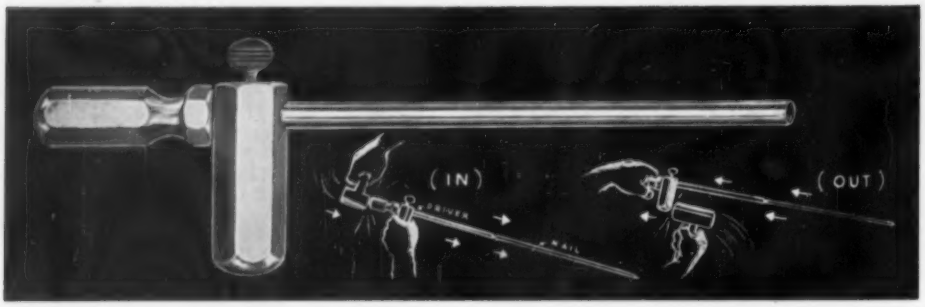

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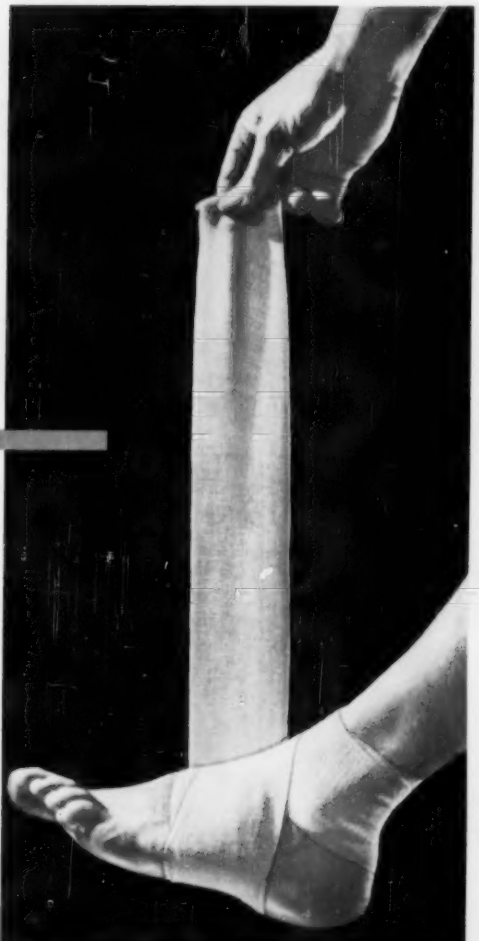

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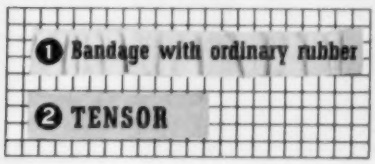

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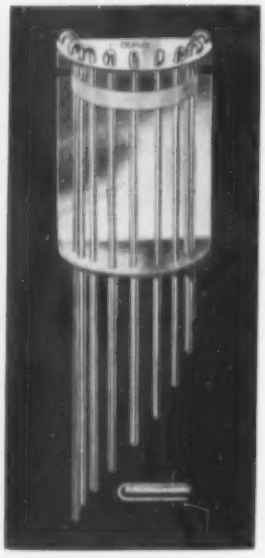

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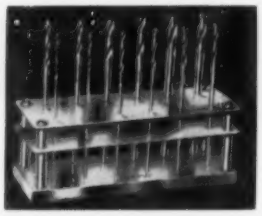

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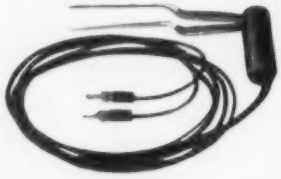

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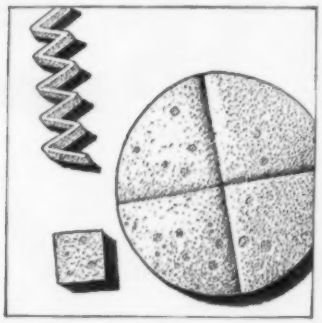

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Reducing Diets • Diabetic Diets • Geriatric Diets • Postoperative Diets

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you

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normal

nutrition

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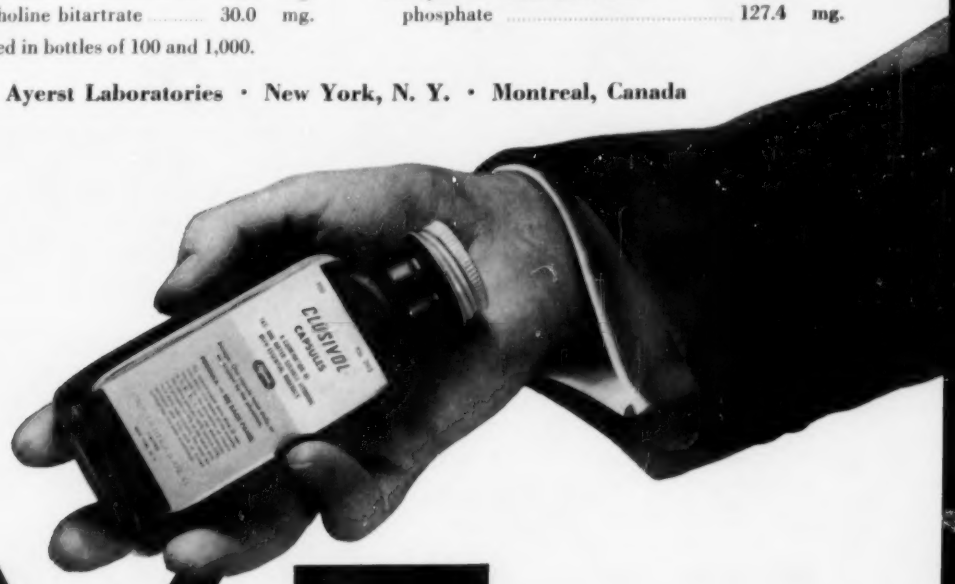
Peptic Ulcer Diets · Low Sodium Diets · Hepatic Disease Diets · Rheumatic Fever Diets

Two "Clusivol" capsules (average daily dosage) provide:

Vitamin A (synthetic)	25,000	U.S.P. Units	Biotin	0.1	mg.
Vitamin D (irradiated ergosterol)	2,000	U.S.P. Units	d-Methionine	20.0	mg.
Vitamin C (ascorbic acid)	150.0	mg.	Cobalt—from cobalt sulfate	0.1	mg.
Thiamine mononitrate (B_1)	10.0	mg.	Copper—from copper sulfate	1.0	mg.
Riboflavin (B_2)	5.0	mg.	Fluorine—from calcium fluoride	0.025	mg.
Pyridoxine HCl (B_6)	1.0	mg.	Iron—from 4 gr. ferrous sulfate exsic.	76.2	mg.
Panthenol, equivalent to of calcium pantothenate	10.0	mg.	Calcium—from dicalcium phosphate	165.0	mg.
			Manganese—from manganous sulfate	1.0	mg.
Vitamin B_{12} U.S.P. (crystalline)	2.0	mcg.	Iodine—from potassium iodide	0.15	mg.
Folic acid U.S.P.	2.0	mg.	Molybdenum—from sodium molybdate	0.2	mg.
Nicotinamide	100.0	mg.	Potassium—from potassium sulfate	5.0	mg.
Vitamin E (as mixed tocopherols natural)	10.0	mg.	Zinc—from zinc sulfate	1.2	mg.
Inositol	30.0	mg.	Magnesium—from magnesium sulfate	6.0	mg.
Choline—from choline bitartrate	30.0	mg.	Phosphorus—from dicalcium phosphate	127.4	mg.

No. 293—Supplied in bottles of 100 and 1,000.

Ayerst Laboratories · New York, N. Y. · Montreal, Canada



Ayerst

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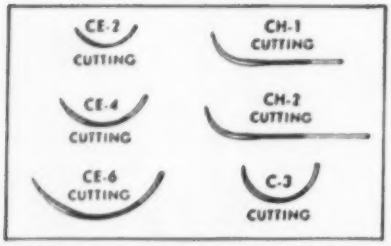
Ideal multiple-vitamin preparation for dietary supplementation



Dermalon *monofilament nylon is available on* ATRAUMATIC *needles shown above. Pliability improved if nurse moistens* DERMALON *before passing to surgeon.*

minimal scarring with D & G's DERMALON®

The patient often judges the skill of the surgeon by the degree of scarring. There is minimal scarring with DERMALON monofilament nylon suture with ATRAUMATIC® needle attached—for example, D & G's CE-4 (⅜ circle cutting edge). This was developed by Davis & Geck at the request of plastic surgeons. It is now widely used for *many types of skin closures* in major and minor traumatic surgery.

After crushing *phrenic nerve, the skin is closed with continuous subcuticular suture of 4-0* DERMALON *monofilament nylon on CE-4* ATRAUMATIC *needle. (D & G Product 1682.)*

Notice neat *approximation of skin edges obtained with* ATRAUMATIC *needle. Needles are always new and sharp. No double strand to pull through tissues.*

On the sixth *postoperative day, suture is withdrawn. Product 1682, of exceptionally smooth* DERMALON, *is very easy to remove.*

30 days later—*hardly a trace of scar, because of surgeon's delicate handling of tissues and* minimal reaction *to* DERMALON *suture and* ATRAUMATIC *needle.*

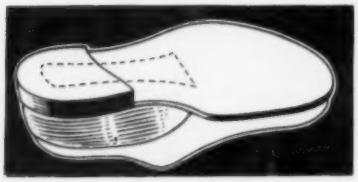
Davis & Geck INC.

a unit of American Cyanamid Company **Danbury, Connecticut**

You'll be glad to prescribe Alden-Pedic shoes

Alden-Pedic
SCIENTIFIC CONSTRUCTION

- Long inside counter
- Heavy gauge ribbed steel shank
- Right and left angled heels, long inside
- Patented bottom filler prevents insole lumping



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Alden-Pedic lasts are designed to accommodate your prescribed corrections and insertions. Extreme sizes stocked. Many styles available. Top quality only.

Alden-Pedic lasts and shoes have been scientifically designed and tested to accommodate specific and general degrees of foot disabilities. Doctors who become familiar with the functional merit of this program will be glad to prescribe these shoes as a foundation in the treatment and correction of foot disabilities. We do not claim that these shoes will correct abnormal foot conditions, but they will provide the types of basic footwear necessary as a foundation in aiding foot trouble and in offering foot comfort. We know you will be glad to recommend them.

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BROCKTON, MASSACHUSETTS

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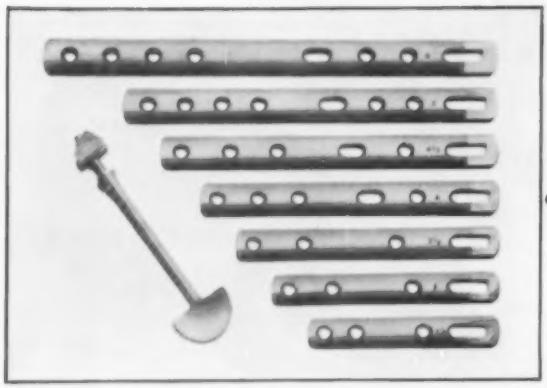
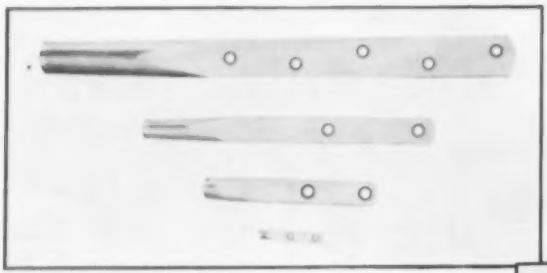
FOR THE ORTHOPEDIC SURGEON





Keeping in step with the requirements and techniques of the nation's foremost surgeons are these three of the newer items in the extensive line of Vitallium Surgical Appliances. Each has been designed by the initiating surgeon to serve a definite need.

COAPTATION PLATES *Venable Type*

The Coaptation plates are used to impact the fracture ends forcefully and hold them firmly impacted. Such impacted coaptation facilitates uninterrupted blood supply to the traumatized bone cells and promotes early bone healing without excessive callus formation.

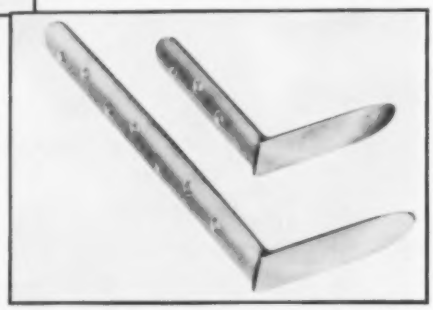
The Coaptor is a necessary tool in the application of these plates. Plates are available in seven lengths of 2½ to 6 inches.

KNEE PLATES *Wright Type*

These acute-angled blade-plates are useful for fractures about the knee, especially supra-condylar fractures, "T" fractures, tibial plateau fractures and distal spiral fractures of the femur. The blade section is driven into the condylar area and the plate screwed to the femur or tibia for a simple, effective fixation.

SPLINES *Bosworth Type*

In 8" (adult) and 5" (children) sizes for geometric osteotomies of the hip. The sharp end is driven through the trochanter into the head of the femur and the spline is attached to the shaft, unbent, in a direct vertical weight bearing position. In 3" size for fractures of the surgical neck of the humerus and for humeral osteotomies. The spline is bent to the appropriate angle driven into the humeral head and screwed to the shaft. The 1" finger spline is for fractured metacarpals and metatarsals and can be bent as desired.



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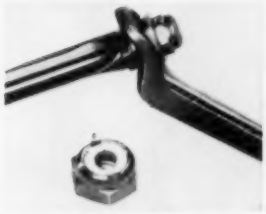
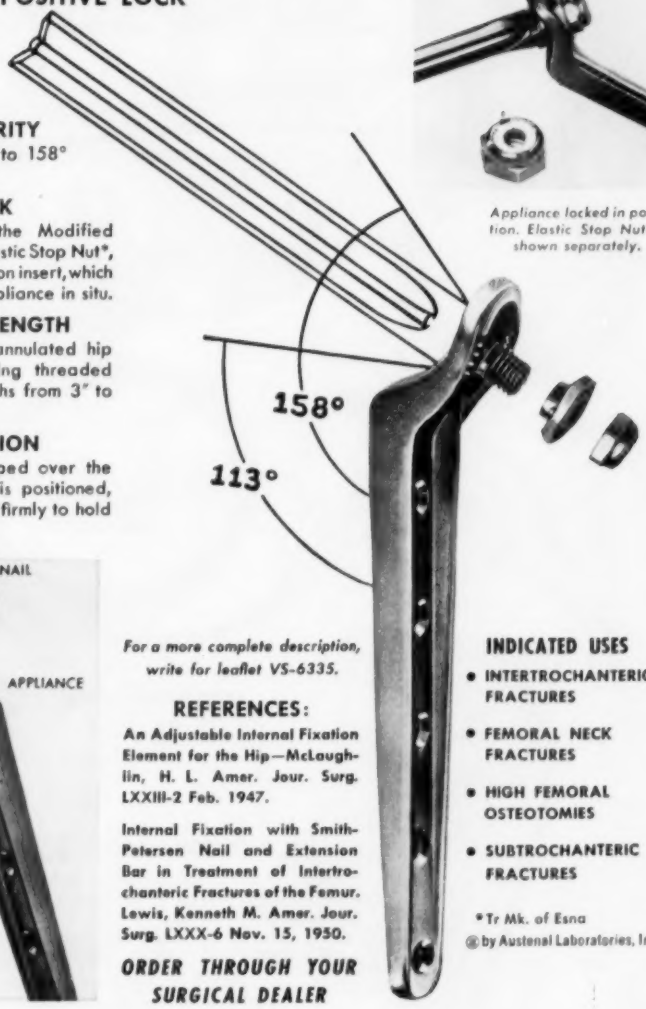
modified AND IMPROVED IN DESIGN

THE Vitallium® McLAUGHLIN INTERTROCHANTERIC APPLIANCE

WITH THE POSITIVE LOCK



Appliance locked in position. Elastic Stop Nut is shown separately.

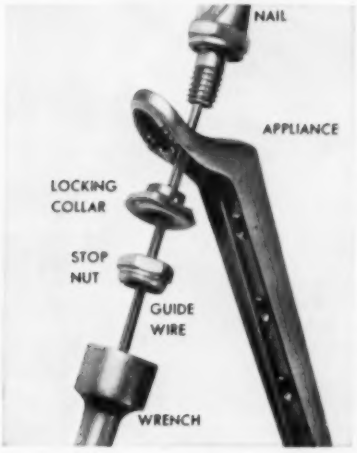


ADJUSTABLE ANGULARITY
Range of angles from 113° to 158° may be obtained.

POSITIVE LOCK
The improved feature of the Modified McLaughlin Appliance is an Elastic Stop Nut*, fitted with an inert surgical nylon insert, which prevents loosening of the appliance in situ.

CHOICE OF NAIL LENGTH
A modified Smith-Petersen cannulated hip nail with a special protruding threaded section is used. Thirteen lengths from 3" to 6" are available.

EASE OF INSERTION
The McLaughlin plate is slipped over the nail end, the locking collar is positioned, and the nut is tightened down firmly to hold the entire assembly securely.



For a more complete description, write for leaflet VS-6335.

REFERENCES:

An Adjustable Internal Fixation Element for the Hip—McLaughlin, H. L. Amer. Jour. Surg. LXXIII-2 Feb. 1947.

Internal Fixation with Smith-Petersen Nail and Extension Bar in Treatment of Intertrochanteric Fractures of the Femur. Lewis, Kenneth M. Amer. Jour. Surg. LXXX-6 Nov. 15, 1950.

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INDICATED USES

- **INTERTROCHANTERIC FRACTURES**
- **FEMORAL NECK FRACTURES**
- **HIGH FEMORAL OSTEOTOMIES**
- **SUBTROCHANTERIC FRACTURES**

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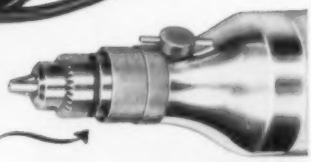
Zimmer
EXPLOSION PROOF
Luck Bone Saw

Approved by the Underwriter's Laboratories for Class I, Group C hazardous locations.

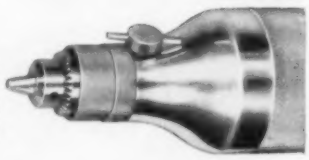
Improved design protects against explosions. Complete unit includes foot rheostat and extension cords.

IT ROTATES
Red Line Shows



IT OSCILLATES

Complete Motor Unit may be sterilized in autoclave.



PACKED COMPLETE WITH ATTACHMENTS
Metal carrying case is equipped with motor, foot pedal, cords and full complement of bits.

ZIMMER MANUFACTURING CO. WARSAW, IND.

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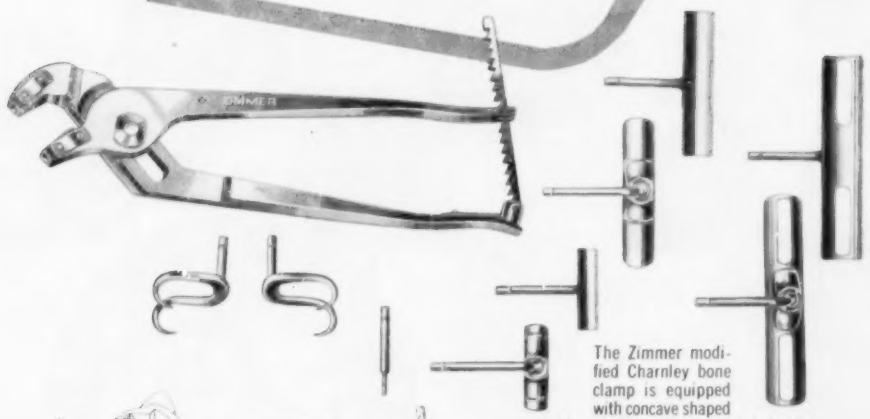
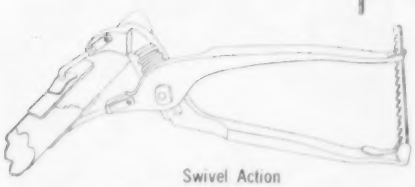
Zimmer

Modification of the Charnley Bone Clamp



The Zimmer modified Charnley bone clamp is equipped with concave shaped serrated jaws to bring fragments into hairline apposition. Special adaptions permit the bone to be accurately clamped regardless of irregularity of contour or taper, and at the same time leaving sufficient bone surface exposed for application of the bone graft or plate. Large jaws slotted for application of bone plates and screws.



Swivel Action

Illustration shows the universal swiveling action of the jaws to permit positive clamping of the fragments regardless of contour or taper.

Patellar Fragments

Hooked jaw attachments permit insertion of screws while holding fragments in position.

Medial Malleolus

Detached fragments are clamped by means of the hooked attachment on one jaw and an anchoring post on the other.

Olecranon Process

Use of the hooked jaw attachment and post is similar to the technique described immediately above.

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It's a SURE MOVE Doctor!

FOR A MORE EFFECTIVE OFFICE PRACTICE —

Profit from the experience of thousands of other L-F users, choose the Model SW 660 short-wave Diathermy. It's simple to operate, easy to use and SAVES hours of your time. *With this diathermy*, there's no need for the busy doctor to refer or defer diathermy treatments. Prescribe for and treat *your* patients in *your* office.

L-F

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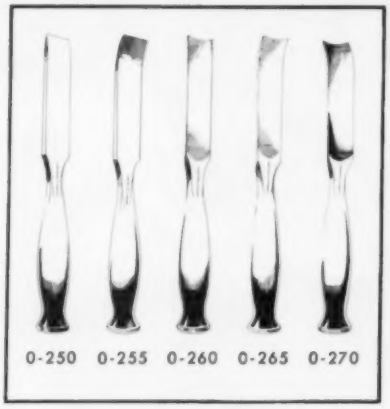
SMITH-PETERSEN OSTEOTOMES and GOUGES



0-250 0-255 0-260 0-265 0-270

0-250 SMITH-PETERSEN OSTEOTOME—straight, 8", sizes ¼", ⅜", ½", ⅝", ¾", 1" and 1¼". Stainless Steel.

0-255 SMITH-PETERSEN OSTEOTOME—curved, 8", sizes ¼", ⅜", ½", ⅝", ¾", 1" and 1¼". Stainless Steel.

0-260 SMITH-PETERSEN GOUGE—straight, 8", sizes ⅜", 9/16", ¾" and 1". Stainless Steel.

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A NEW STAINLESS STEEL CASE TO HOLD SMITH-PETERSEN OSTEOTOMES and GOUGES

0-295 Open

CASE 0-295—holds seven Smith-Petersen Osteotomes.

CASE 0-296—holds seven Smith-Petersen Gouges.

CASE 0-297—holds a combination of seven Osteotomes and Gouges.

Cutting edges are protected at all times. Complete unit may be autoclaved.

0-295 Closed

Specify Width of Gouges and Osteotomes When Ordering

ESTABLISHED 1838

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MAKERS OF SURGEONS' INSTRUMENTS

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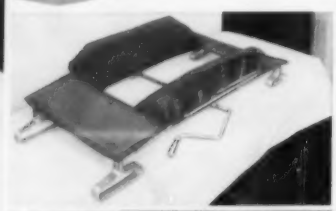
Zimmer

Tools & Equipment for Spinal Surgery



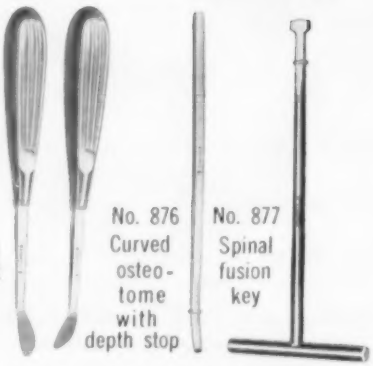
No. 551 Wilson Convex Frame for Spinal Surgery. Positions patient with spine in flexion and with no pressure on abdomen, resulting in less hemorrhage. Adjustable during surgery. Operating time is greatly reduced.

No. 444-A

No. 444-B

Holscher Root Retractors

Stainless steel retractors for spinal surgery. Retract nerves without interfering with use of rongeurs and other instruments.



No. 875 Right facet rasp and left facet rasp

No. 876 Curved osteotome with depth stop

No. 877 Spinal fusion key

These four instruments are for vertebral body and facet fusion. Write for technique of use.

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THE

ANOTHER NEW DEVELOPMENT OF THE

Johnson & Johnson

RESEARCH LABORATORIES

ZOROC
HARD-COATED
RESIN-PLASTER
BANDAGES

The New **RESIN-PLASTER** *Bandage*

FOR many years, "SPECIALIST"* Plaster of Paris Bandages have been the product of choice of a large majority of orthopedic surgeons and hospitals throughout the United States.

Since its introduction on July 1, 1952, "SPECIALIST" Orthopedic Resin has also become increasingly popular for use *in conjunction with* "SPECIALIST" Bandages, to strengthen and lighten plaster casts and fortify them against water and urine erosion.

Now, we are proud to announce that our Research Laboratories have succeeded in combining all of the proven advantages of "SPECIALIST" Bandages and "SPECIALIST" Orthopedic Resin in our new product—the ZOROC* *Resin-Plaster* Bandage.

Extensive clinical studies in the departments of orthopedic surgery of outstanding teaching hospitals in this country have clearly shown that casts made from ZOROC Resin-Plaster Bandages are markedly superior to ordinary plaster casts in strength, durability and resistance to water and urine erosion.

These studies indicate that, with ZOROC Bandages, cast-weight and thickness can be reduced by as much as 50%, depending upon the particular type of cast and the degree of stress to which it may be subjected.

Application-time is correspondingly shortened; the marked reduction in cast-weight enhances patient-comfort; and the reduction in thickness materially reduces interference with X-ray penetration.

ZOROC casts are unaffected by water, remain strong and durable even when constantly exposed to urine in the case of children or incontinent patients, and may be scrubbed to keep them clean.

All of the advantages inherent in the use of synthetic resins to reinforce plaster of Paris have been incorporated in the ZOROC Bandage—while the disadvantages previously encountered in the mixing and disposal of resin solutions have been eliminated.

ZOROC Resin-Plaster Bandages are available now, in three sizes, through your dealer or our representative, who will be glad to supply further information and prices.

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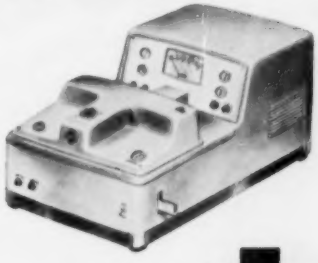
EXCLUSIVE ELECTRONIC SHARPOMETER...

***Guarantees* A·S·R BLADES**

THE SHARPEST EVER MADE!



The NEW EXCLUSIVE A. S. R. SHARPOMETER... **the only device of its kind in the world...** measures the CRITICAL EDGE-FINENESS of every lot of

A. S. R. SURGICAL BLADES

EDGE-FINENESS determines perfect cutting qualities. Sharpometer Edge-Fineness tests enable A. S. R. to ***guarantee*** . . . precise, uniform sharpness and dependability for every single blade!

NEVER AGAIN will the surgeon suffer embarrassment due to dull blades. A.S.R. SURGICAL BLADES . . . Sharpometer tested . . . *are your safe-guards.*

PROVED SHARPNESS: Sharpometer tests on competitive blades including re-sharpened ones, have proven . . . beyond a doubt . . . A.S.R. SURGICAL BLADES are uniformly sharper.

NO WIPING REQUIRED — blades are wrapped in rust inhibiting paper.

A.S.R.
PRECISION PRODUCTS

EVEN THE PRICE IS A PLEASANT SURPRISE

Telephone, write or telegraph NOW for New Descriptive Booklet — "SHARP SURGEONS' STEEL"

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DEMAND GENUINE **NEUFELD NAILS** *and* **SCREWS**

—IN **NEUTRILIUM®**

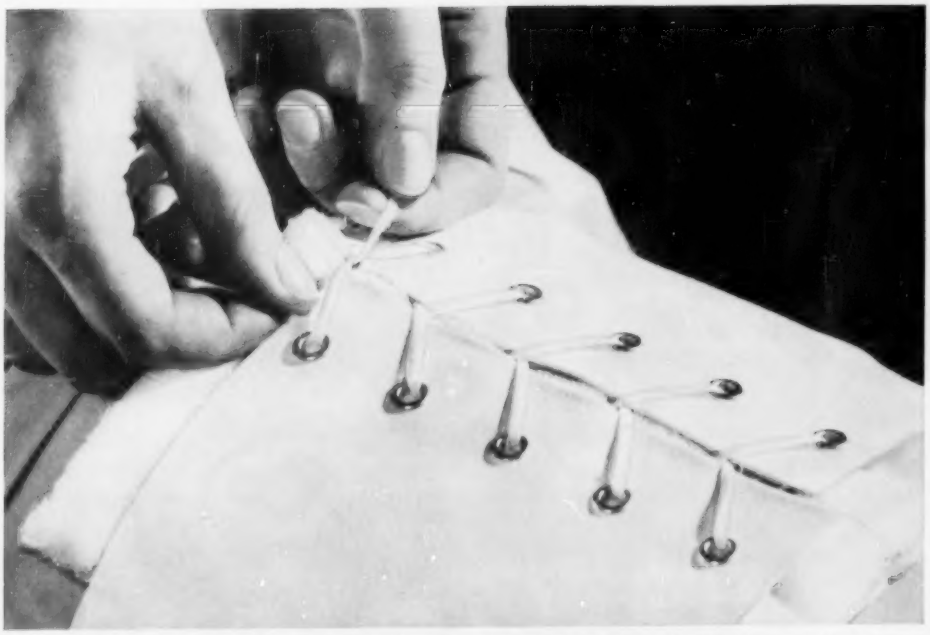
NEUTRILIUM® is the most non-corrosive metal known to science. Its proven super-strength lends an assurance of permanence to internal fixation of the trochanteric area. This neutral, non-magnetic, homogenetic alloy is entirely inert and therefore compatible with human bone or tissue, remaining unaffected by body chemistry.

NEUFELD BONE SCREWS — of ***NEUTRILIUM®*** — are cold forged and, unlike other metals, appear to be unbreakable under maximum human pressures. Heads will not twist off during application or in actual use.

GENUINE NEUFELD NAILS and SCREWS — of ***NEUTRILIUM®*** — made only by MEDICAL RESEARCH SPECIALTIES, Loma Linda, California, are sold nationally by leading surgical and orthopaedic supply dealers.

NEUTRILIUM® *is a registered Trade Name of Medical Research Specialties.*

NEUFELD FEMORAL NAIL PLATE
Used for internal fixation of intertrochanteric and subtrochanteric fractures.
Write for descriptive literature
MEDICAL RESEARCH SPECIALTIES
Loma Linda, California



Especially valuable in heavy drainage cases, *Curity* Ready-Made Adhesive Ties are easy to use for either "Montgomery straps" or "adhesive corsets". Simply cut lengths desired, apply adhesive section to skin, and lace dressing firmly over wound. To change dressings, just untie, replace pad and retie.

Now! Examine the patient...change the dressing *-without removing the adhesive!*

Curity *Ready-Made Adhesive Ties Save Time and Trouble . . . Tape is Non-Wrinkling, Comes Off Clean*

You can see the advantages of this dressing at a glance—it simplifies your examination of the patient, and makes it far easier and quicker to change dressings. Saves you time. Saves adhesive and cuts down nurse time for the hospital. Eliminates patient discomfort from frequent tape removal.

Made with finest *Curity* Adhesive, *Curity* Ready-Made Adhesive Ties hold the dressing securely, stay on for days through many dressing changes. New *Curity* adhesive mass gives added sticking power, yet comes off clean when removed. Helps eliminate tape shifting, corner curling and wrinkling without loss of desired flexibility. And you can't buy a *less irritating* adhesive!

Why not try this convenient *Curity* dressing technic? Available in 9-inch and 5½-inch widths, in 5-yard rolls, with metal eyelets spaced at 1¼-inch intervals.

Curity
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ADHESIVE TIES

BAUER & BLACK

Division of The Kendall Company
309 West Jackson Blvd.
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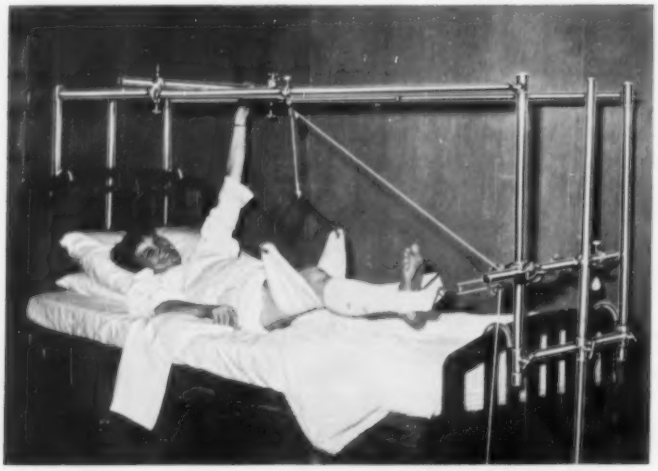
Attaches to Any Bed...Easily, Quickly

Stryker

UNIVERSAL OVERBED FRAME



Double bar unit assembled and in use, showing patient in Russell's traction.

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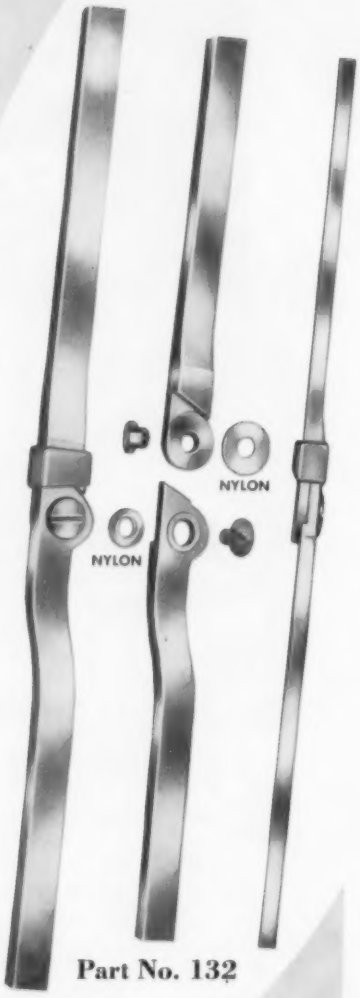

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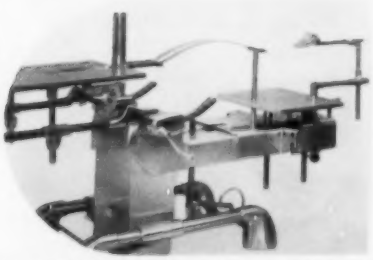

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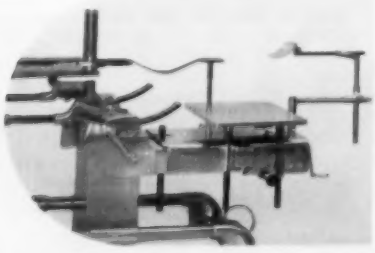
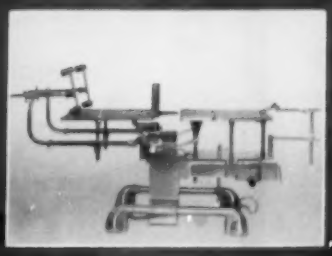


1800



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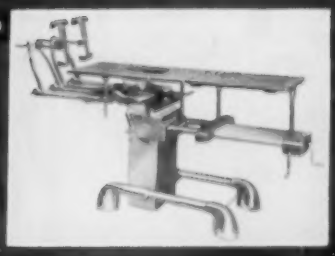

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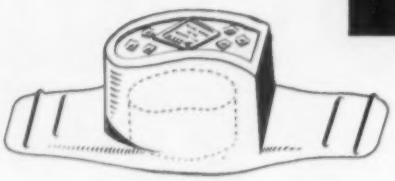

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18-8 SMO Stainless Steel made in
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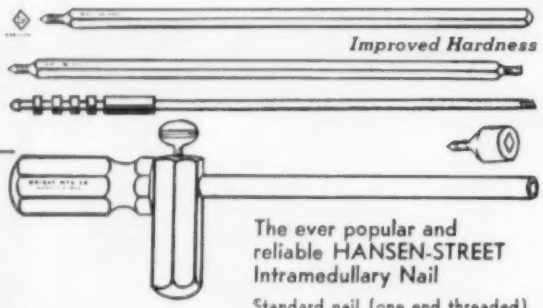

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1. Cowart, E. C., Jr.: Mississippi Doctor 29: 278 (April) 1952.
2. Sayer, R. J., et al.: Am. J. M. Sc. 221: 256 (March) 1951.
3. Knight, V.: New York State J. Med. 50: 2173 (Sept. 15) 1950.
4. Trafton, H. W., and Lind, H. E.: J. Urol. 69: 315 (Feb.) 1953.

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XYLOCAINE
HYDROCHLORIDE 2%
the
fourth dimension
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PREFERRED local anesthesia
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Steroid-nutritional Compound for Use in Preventive Geriatrics

Each 15 cc. (3 teaspoonfuls) contains:

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Thiamine HCl (B_1)	5.0	mg.
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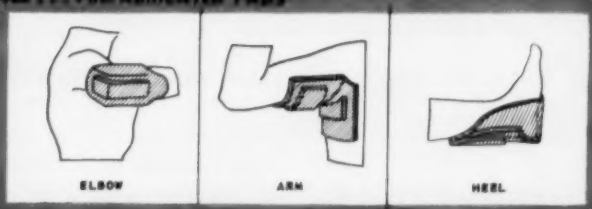

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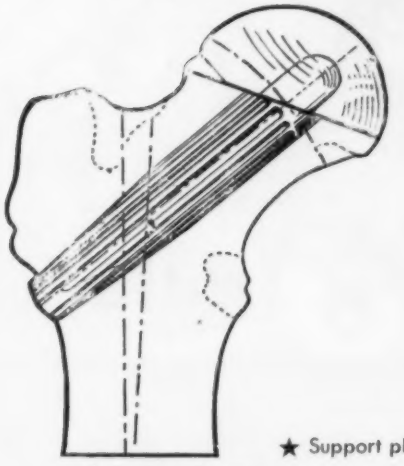

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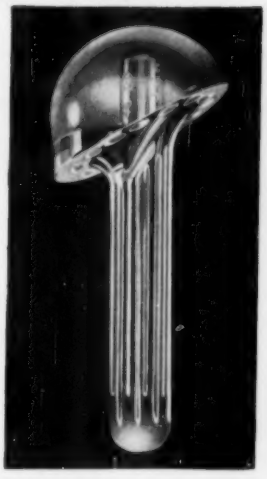

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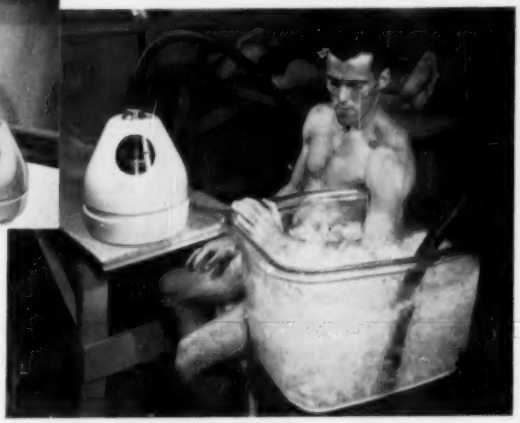

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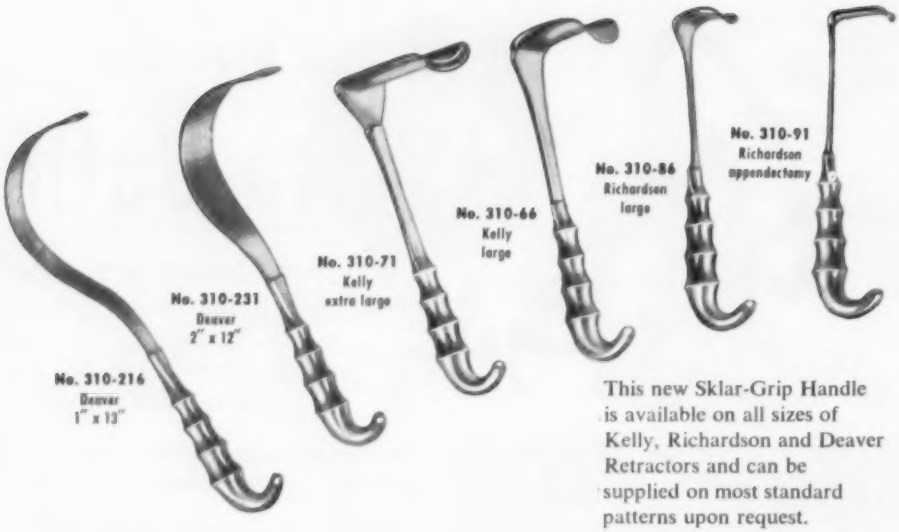

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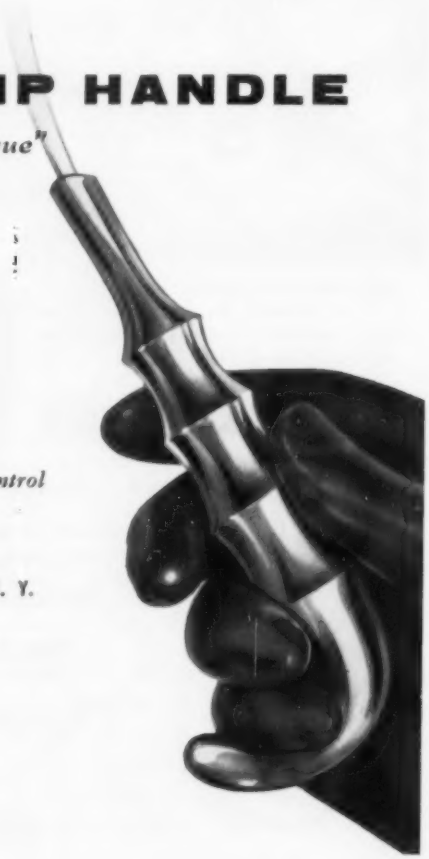

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*Choy, D.S.J.: Clinical trials of a new plastic dressing for burns and surgical wounds. A.M.A. Arch. Surg. 68:33-43 (Jan.) 1954

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1927: Vol. IX (Old Series Vol. XXV), Nos. 1, 2, 3, and 4; January, April, July, and October.
1928: Vol. X (Old Series Vol. XXVI), Nos. 1, 2, and 3; January, April, and July.
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GLOBAL ORTHOPAEDICS *

BY HAROLD B. BOYD, M.D., MEMPHIS, TENNESSEE

Modern transportation and communication have contracted the world until all nations are neighbors. To promote peace and to live to the best advantage of all, we should know and understand one another. Toynbee [1], the historian, has given us the example of the democracy of Attica. Five hundred years before Christ, this direct form of democracy functioned because in a day's journey on foot any citizen could reach the capital to cast his vote. In many of our older states, the counties were made approximately twenty miles square, to permit a farmer, with his horse and wagon, to reach the county seat, transact his business, and return home in a day. Air transportation and present methods of communication have made the United States smaller, in many respects, than Attica 500 years before Christ, or a Virginia county in George Washington's time. By plane, any citizen of our country can go to Washington, D. C., in a day; and by telephone or television we can talk or see from one extreme of the country to the other. By regular scheduled airlines one of us, leaving Chicago, can be in Buenos Aires in one and one-fourth days, in Johannesburg in two and one-half days, or in Calcutta in less than three days — the last, 180 degrees of longitude plus or minus from Chicago, depending on whether we choose to travel east or west. With this apparent shrinkage of time and space, vast political changes have occurred. The invention of ocean sailing ships in the fourteenth century transferred political power from the city-states of Europe to the nation-states of Europe. From the sixteenth century until the twentieth, the world was controlled largely by these nation-states. The airplane and other technical developments have shifted the mantle of world power primarily to two geopolitical poles — that to the West in the United States and that to the East in the Soviet Union. Today, basic world problems stem from the fact that our technology has been revolutionized within the lifetime of many of us, while human nature and the human psyche have changed little in the 6,000 years of recorded history.

You may say that this is no affair of ours; the United States did not court, desire, or choose global responsibility. Nevertheless, we are living in a time when one of the gigantic tidal waves of history is running strong and deep, and in our direction.

The greatness of our nation depends upon the seriousness of our attitude toward our problems and opportunities. Every citizen of this country should arise to his responsibilities. This is peculiarly true of those engaged in the practice of medicine and surgery. We speak an international language as no other group can. Anatomy, physiological response to trauma or disease, and psychological reactions of patients are little influenced by race or place of residence.

We have been a large, fast-growing, relatively self-contained nation and have not felt the practical necessity of learning languages other than English. In our inheritance of the English language, we have been singularly fortunate. One hundred and fifty years ago Latin was the language of science. Seventy-five years ago German was the scientific tongue. Fortunately for us, English has become the principal language of science in our

* Presented as the President's Address at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Chicago, Illinois, January 26, 1954.

day. This is a two-edged sword; it spares us the absolute necessity of learning a foreign tongue, but it causes us to neglect or to delay acquiring a knowledge of important scientific facts developed in other countries.

Before the War of 1914–1918 and between the World Wars, medical men from all over the world traveled in large numbers to Europe to obtain, or to continue, their medical education. Fewer North Americans now go to Europe for this purpose. In fact, this trend has been partially reversed and many surgeons are now coming to the United States from Europe and from the rest of the world for specialized training. This is particularly true in cardiac surgery, and it is true in no small degree in orthopaedic surgery. We should welcome this opportunity to repay at least in part our debt to European science and medicine.

Let us review quickly our past achievements and future responsibilities and consider measures to strengthen our position in the field of orthopaedics. In the twenty-one years of its existence, the Academy has enjoyed a rapid growth. Our membership now totals 1,797. At the beginning of this century, orthopaedics was a small, non-operative specialty, the tools of which were "bloodless surgery", straps, buckles, braces, and an occasional subcutaneous tenotomy. Today, it is a fully recognized surgical specialty, with organized societies in most countries of the world. The chief function of the anatomy with which we deal is locomotion and support; therefore, it is natural that our work should be, in a large measure, mechanical. We have developed more operations than any other specialty. There seems to be no limit to the number of surgical procedures concerned with the transplantation of muscles, osteotomies, arthrodeses, remodeling of joints, or to the methods of treatment of a variety of fractures; and now, in addition to external prostheses, we have added internal prostheses! We are justly proud of our mechanical advances.

From our clinical research and end-result studies, we know approximately what can be accomplished by well established procedures. These important activities should not be allowed to consume our entire scientific energy. We must seek to develop new fields, for our work and our practice are constantly changing. Less than twenty years ago, the crippled children's hospitals and orthopaedic services of our country were crowded with patients afflicted with chronic osteomyelitis, tuberculosis of bones and joints, and grotesque deformities resulting from poliomyelitis. Chronic osteomyelitis has been almost eliminated; tuberculosis is rare; "quadrupeds" and other severe deformities are no longer permitted to develop after infantile paralysis. Now we have hope that a vaccine may eliminate poliomyelitis in our lifetime, as smallpox was eliminated in the days of our fathers.

In the future, first, we should sponsor research which will develop new methods and new fields of activity for orthopaedists. Our deficiency in basic orthopaedic investigation should be corrected promptly. This was emphasized by Dr. McKeever in his Presidential Address last year, and by Dr. Shands in a recent article in our Academy *Bulletin*. We should become more closely associated with men doing basic research in order to participate in their work, and to acquaint them with the special problems of our field. We must encourage basic investigation in orthopaedic surgery, even when no practical application is apparent. Nuclear physics had little obvious value twenty years ago. Now it is vital to our survival and has placed in our hands the most valuable tool for biological research since the invention of the microscope.

Second, we must increase our efforts to treat traumatic lesions more efficiently, constantly improving ways to shorten convalescence and to lessen the percentage of permanent disability. We should develop better methods to rehabilitate our patients, both physically and psychologically. Insurance companies are vitally interested in the problem of restoring the injured to useful work. Much thought and research are needed to lessen the tendency on the part of many patients and some employers to allow insurance benefits to delay the patient's return to a gainful occupation.

We, as an Academy, must do more than hold an annual meeting and "talk to each other". It will take cooperative effort and extensive financing to promote many needed projects. The organization and financing of the American Surgical Materials Association, which will standardize materials to be left in the human body, as recommended by Dr. Barr and his Committee, is an important undertaking. There are many other useful projects which readily come to mind. In this country there are funds available for such projects, provided the donors have confidence in the recipient's ability to use the financial aid properly. The coordination and financing of these projects will require time and "know-how", both of which are often not available to the busy practising orthopaedic surgeon. This being true, we should follow the recommendation of the Committee for the Advancement of Orthopaedic Surgery and employ a full-time executive secretary for the Academy. Several other medical specialties have taken similar steps with outstanding success. The proper man in this post could do much to facilitate the development of the Academy and to help to secure financial aid from industry, insurance companies, and others to the advantage of all concerned. We shall now return to our theme of global orthopaedics.

SOUTH AMERICA

In the past, physicians of both North and South America have looked for scientific instruction to Europe, where lie the roots of our ancestral and cultural backgrounds. While North America turned principally to England and Germany, South America looked for the most part to France and Italy. As a result, there are many South American orthopaedic surgeons who were trained in France or Italy. Men trained by Putti are to be found in many of the leading orthopaedic centers in South America. For his accomplishments as a teacher, organizer, medical author, and surgical technician, historians will remember Vittorio Putti as one of the greatest orthopaedic surgeons of the twentieth century. Before the days of international flight, this genius from Bologna traveled to South America, lectured to, inspired, and encouraged outstanding young surgeons in the field of orthopaedic surgery. On returning to Italy, with prophetic judgment, he established fellowships for South American surgeons. These men, trained in the *Istituto Rizzoli*, have become outstanding leaders and teachers of our specialty.

The Kellogg Foundation has furnished help to more than twenty young orthopaedic surgeons from Latin America who wished a year or more of resident study in the United States. Most of these men were trained during the years 1943 to 1947, when a committee from this Academy cooperated with the Foundation in selecting and placing the trainees. The Kellogg Foundation has spent a large sum of money in this worthy project. These men are now playing a prominent role in the advancement of orthopaedic surgery in South America. Unfortunately, no organization is carrying on a similar orthopaedic training program at the present time.

Because of changes in international relationships and because of the technical developments of our age, North and South America are becoming more closely knitted together. Now is the time to strengthen the ties between the two continents; each has a great deal to learn from the other. Young surgeons from South America should be encouraged to take training in this country, and young men from our country should be encouraged to study there. In addition, mature orthopaedic surgeons from both continents should visit each other. Genuine friendships and mutual respect for work accomplished and orthopaedic ideas developed will result from these visits. Young orthopaedic surgeons from this country could derive great benefit from a period of resident training on some of the orthopaedic services in South America. A year spent in one of these clinics would be of great value. It would give them a wider knowledge of orthopaedics and a broader cultural background.

The leaders in orthopaedic surgery in South America have little national prejudice

regarding the origin of surgical procedures. Many of them read two or more foreign languages, especially French, Italian, English, or German. Hence, they are in a position to try, coordinate, and evaluate orthopaedic methods which originated abroad, along with their own. These are apt to be slowly absorbed in North America, where we are often prejudiced in favor of ideas developed and published by English-speaking authors.

It was my pleasure, last year, to visit nine of the ten Republics of South America. The average North American orthopaedic surgeon would be amazed at the progress being made there. This vast continent is developing with unbelievable rapidity. The cities are modern and the hinterland is being opened up by means of trucks, tractors, and airplanes, not with horses and oxen as in the early days of our westward expansion. Some of the hospitals and clinics in these countries are as modern as any in the world. They have been built recently, are of contemporary architecture, and are furnished with up-to-date equipment. By contrast, several of their hospitals and schools are venerable institutions, steeped in tradition. San Marcos University, in Lima, is the oldest university in the western hemisphere. Its doors were opened in 1551, eighty-eight years before the first university was founded in North America. Much of our lack of appreciation of South American orthopaedics stems from a paucity of knowledge on our part. Orthopaedic services in Latin America have an enviable record of past achievement, present accomplishment, and a future of great promise.

THE ORIENT

In spite of our many contacts with the Japanese since World War II, we have had little first-hand opportunity to evaluate their progress in orthopaedics. We welcome the extensive report of the proceedings of the Japanese Society of Orthopaedic Surgery which appears in the January issue of *The Journal of Bone and Joint Surgery*.

We have had meager orthopaedic contacts with the peoples of Asia and the Pacific Islands, such as Indonesia. The exchange of orthopaedic concepts with them may be more difficult because of a difference in cultural backgrounds, but we must not shrink from tasks because they are arduous. More time will be needed, but the development of our specialty in these areas is important.

THE TRAINING OF SURGEONS FROM ABROAD

Many young orthopaedic surgeons from abroad are anxious to come to the United States for orthopaedic training but are unable to do so: first, because our residencies are filled by our own men and second, because the dollar exchange rate often creates an expense in addition to the usual financial sacrifice imposed on the young surgeon who desires training abroad. Our training programs are adjusted to the Orthopaedic Board requirement of three years. This is too great a period, from the standpoint of both time and expense, for the average young surgeon to be away from his country. To aid in solving this problem, our larger orthopaedic centers should arrange shorter special services in addition to their regular residencies. These would accommodate men who have been partly trained in their own countries and who desire further training in the United States. A cooperative plan should be set up among several orthopaedic centers, so that a young surgeon who wishes a year's training could spend six months in one center and an additional three months in each of two others. Thus he would gain a broader concept of North American surgery. Unless he speaks English fluently, he should stay at least six months in the first location, acquiring the language, together with a knowledge of the customs of a foreign land.

History will probably reveal that the United States needed friends in the second half of the twentieth century as she never had before. We should take steps to make it easier, both professionally and financially, for interested men to study orthopaedic surgery in our country. The financial aid should not be a *de luxe* "handout" for surgical tourists, but

genuine financial assistance to earnest young men willing to make sacrifices for orthopaedic training. They will appreciate the training all the more because of their sacrifice. We should organize suitable training programs for visiting young surgeons from other countries. Then we should stimulate interested groups to furnish financial assistance to selected candidates.

ORTHOPAEDIC SOCIETIES

In all fields, scientific organizations furnish a common meeting place for the direct exchange of opinions. Face-to-face discussions enable us to obtain the reactions of others to our views. As a result, thoughts may be altered or new ideas may be developed but, most important, we are stimulated to further work and study. Through this agitation of ideas, the less worth-while are eventually sifted out and the more important are preserved. The personal contacts enable us to evaluate each other in regard to conservatism, optimism, or unwarranted enthusiasm. This is important as we study the writings of various authors. While the presentation of papers disseminates knowledge, stimulates new thought, and encourages us to evaluate new principles, of greater value are the personal contacts and friendships made.

Of importance in orthopaedic societies are the small traveling study groups. These usually consist of twenty to thirty men with mutual interests. They meet in different locations annually for discussion of their successes, failures, and problems. These small groups, where all are personal friends, encourage frank, informal discussion and criticism. In these groups often germinate concepts which are later presented to national societies of which The British Orthopaedic Association, the *Sociedade Brasileira de Ortopedia e Traumatologia*, The American Orthopaedic Association, and The American Academy of Orthopaedic Surgeons serve as examples. In these national societies guest speakers from other countries enable us to obtain thoughts from beyond national boundaries.

The *Sociedad Latino-Americana de Ortopedia y Traumatología* is an international society with 453 members from eighteen Latin-American countries. Meetings of the *Sociedad* are held every three years. They met for one week at Quitandinha, Brazil, in July 1953. Orthopaedic surgeons were registered from Mexico and Cuba in the north to Argentina and Chile in the south. Guest speakers were present from six European countries, England, and North America. In addition to a large number of scientific papers and symposia, there were motion pictures and scientific and commercial exhibits.

On the world level, the *Société Internationale de Chirurgie Orthopédique et de Traumatologie*, which holds its meetings once in three years, now has a membership of 535 from forty-three countries. The maximum membership from a given country varies from five to 100 and is based primarily on the total number of orthopaedic surgeons in the country represented. This group is doing much to advance global orthopaedics and to promote international friendship and understanding in our specialty.

THE ENGLISH-SPEAKING WORLD AND THE JOURNAL OF BONE AND JOINT SURGERY

The greatest unifying force in orthopaedic surgery today is *The Journal of Bone and Joint Surgery*. In it are recorded scientific advancements, evaluation of end results, and reports of orthopaedic activities. It is read by orthopaedists and other interested surgeons throughout the entire world. The beginning of joint publication of the British and American Editions of the *Journal* in 1948 marked a major step in the advancement of our specialty. This was not accomplished without misgivings and much discussion on both sides of the Atlantic. Despite this, it was accomplished and, furthermore, it has been a marked success. We have a clearer concept of orthopaedic surgery in the British Isles, Europe, Australia, New Zealand, Africa, and Canada, than we had before. We should be proud that our *Journal* is the outstanding example of cooperative publication of a

truly international surgical journal. The *Journal* has always maintained a high scientific standard and has been second to none in its format, quality of printing, and editorial excellence. These standards have been maintained by editors who have labored far beyond the call of duty. Through the years the American Volume has received considerable financial support from The American Orthopaedic Association. In many ways The American Orthopaedic Association is the parent organization of the Academy. As occasionally happens, the child may grow to be larger, richer, and, possibly, more influential than the parent. Nevertheless, the appreciative child continues to honor and respect the parent. The *Journal* is of great value to the Academy, to the Association, and to the whole medical world.

The *Journal* must grow and expand with our specialty. This necessitates a larger constituency and a wider financial base. For many years the Academy has benefited from the *Journal* without assuming its share of the responsibility for its publication. During this past year a Joint Committee from the Association and the Academy worked out a plan for cooperative publication of the American Volume of the *Journal*. This affords the Academy the opportunity to assume its proper responsibilities in relation to the *Journal*. When the questionnaires on this subject were mailed to the Academy membership, more than two-thirds replied, indicating active interest in this project. Over 98 per cent. of those replying were in favor of the joint publication of the American Volume by the Association and the Academy. Accordingly, the Academy Executive Committee in conjunction with the Association authorized the formation of the necessary new corporation for the management of the American Volume of the *Journal*. Under this new plan, the *Journal* will be able to expand more rapidly and to develop projects hitherto not feasible. It is my hope that, with the expansion of the *Journal*, careful thought will be given to securing more material from other countries. For example, it is possible that, eventually, a section of the *Journal* or an annual issue could be devoted to papers from Latin America. In this way, we would become better informed regarding Latin-American orthopaedic surgeons and their work.

LOOKING AHEAD

The realization of universal humanitarianism, of which global orthopaedics is a part, is impossible while one-fourth of the land surface of the earth and one-third of its people remain behind the Iron Curtain. We are living in a large and powerful country; nevertheless we cannot afford a Laodicean * attitude. Eventual world stability depends on medicine and surgery more than on any other field, except government and diplomacy, for it is the minds and emotions of men that should meet without clashing. Big and powerful nations need friends most, for power alone cannot long control world affairs. When men understand freedom, they will welcome and adopt it. We must shed the shackles of provincialism in order to preserve and to extend the free way of life.

1. Toynbee, Arnold J.: Men Must Choose. Atlantic Monthly, **191:** 27, 1953.

* ". . . rich, and increased with goods, and have need of nothing". Revelation 3: 17.

TUBERCULOSIS OF THE SPINE

An End-Result Study of the Effects of the Spine-Fusion Operation in a Large Number of Patients *

BY HALFORD HALLOCK, M.D., AND JAMES B. JONES, M.D., NEW YORK, N. Y.

From the New York Orthopaedic Hospital, New York

At the New York Orthopaedic Hospital, spine fusion has been the treatment of choice for tuberculosis of the spine at all ages since January 9, 1911, when Russell A. Hibbs performed the first spine-fusion operation. The operation was designed to eliminate motion of the diseased vertebrae, as experience had shown that the limitation of mobility obtained by corsets, braces, and casts had been beneficial. Absolute immobilization of a diseased joint can occur only when its component bones become fused, and it was believed that in this way cure of the spine lesion would be hastened and the deformity, or its progress, would be prevented.

It must never be forgotten that the articular lesion is but a local manifestation of a tuberculous infection and that treatment of the patient's general disease is of utmost importance. With the modern use of streptomycin and the isonicotinic acid hydrazides, this can be accomplished much more readily. Treatment of the local lesion, as well as of its complications, is made more efficacious by their use.

In the thirty-six-year period from 1911 through 1947, some 1,009 patients have had spine-fusion operations for tuberculosis of the spine at the New York Orthopaedic Hospital. It is probable that the actual number is somewhat greater, as some of the records may have been lost or misplaced. Provided there were no general contra-indications to a surgical procedure, there was no selection of cases except for the elimination of patients with active pulmonary disease, who had to be cared for in hospitals with contagious units. Thirteen patients died shortly after operation,—eight from shock, one from acidosis and pneumonia, one from myocardial failure, one from an embolus, one from postoperative streptoccocal infection, and one following a laparotomy for intestinal obstruction. This represents an operative mortality of 1.28 per cent.

In 1918, Russell Hibbs [1] reported 210 patients who were operated upon from January 1911 to January 1915; after a mean follow-up time of five years, 157 patients (74.7 per cent.) were considered cured of their spinal tuberculosis, in twenty-two the results were doubtful, and thirty-one (14.7 per cent.) were dead, the majority having died from some form of tuberculosis. Hibbs and Risser, in 1928, reported 286 patients who were operated upon from 1915 to 1920 inclusive. The follow-up period was from seven to thirteen years and the results were known in 256 cases. Cures were obtained in 181 cases (70.7 per cent.) and were not achieved in 3.1 per cent. Death, mostly from tuberculosis or directly related causes, occurred in 26.2 per cent.

On January 23, 1940, Walker E. Swift [2] reported a study of 817 patients who had been operated upon from 1911 to 1930 inclusive. Of these, 584 patients (71.4 per cent.) were followed for at least five years or were known to have died. Excellent results—that is, good condition clinically and roentgenographic evidence of entire subsidence of the lesion —were obtained in 72 per cent. of the children under ten years of age (332 cases) and in 53 per cent. of the group eleven years of age or older (252 cases). With the age groups combined, excellent results were secured in 64 per cent. Failure resulted in 8 per cent., but the patients were still living, and death occurred in 28 per cent. Again, some form of tuberculosis was responsible for a large number of the deaths (53 per cent.), but when the

* Read at the Annual Meeting of The American Orthopaedic Association, Hot Springs, Virginia, June 30, 1953.

TABLE I

FREQUENCY OF INVOLVEMENT BY AREA

Diseased Segments	No. of Cases
Cervical and cervicothoracic	2
Upper thoracic	14
Lower thoracic	63
Thoracolumbar	39
Lumbar	73
Lumbosacral	16

total number of deaths from this cause was related to the number of patients who were followed for at least five years, only 15 per cent. of the group had died of tuberculosis. Of the 584 patients, 356 (61 per cent.) had been followed for periods of from ten to twenty-four years.

The study has been continued, and the group of patients who were operated upon from 1931 to 1947 inclusive has been analyzed. In addition, further examinations have been made by members of the Staff, beginning after 1940, on many of those patients who had been operated upon in the 1911–1930 period, thus providing an opportunity of observing some really long-term end results.

AN ANALYSIS OF THE GROUP OF PATIENTS WHO WERE OPERATED UPON FROM 1931 TO 1947

During the years 1931 to 1947 inclusive, 192 new patients with tuberculosis of the spine were operated upon. Most of these patients had had no previous treatment, or the treatment had been of little benefit. A few had undergone previous spine-fusion operations, but active disease was still present (either in a second focus or as a progression of the disease in the original focus), and there was failure of arthrodesis or the fusion was found to include too few vertebrae.

Of these new patients, 100 were followed for five years or more, fifty-three were followed for less than five years, and thirty-nine patients died. The series included 103 females and 89 males. Only 30 per cent. of the patients were younger than ten years of age, a marked contrast to the 56 per cent. incidence reported in the series of 1911 to 1930. The average age for the group was twenty-five years, the youngest patient being fifteen months old at the time of operation and the oldest seventy years of age; both progressed extremely well after operation and had final complete arrest of the disease.

The duration of symptoms before operation varied from two weeks to thirty-three years; the average duration, thirty-three months, has been made higher by a few patients who had had the disease for a long time.

TABLE II

NUMBER OF VERTEBRAE INVOLVED

Vertebrae	No. of Cases
1	2
2	98
3	34
4	26
5	17
6	8
7	3
8	2
9	1
10	1

The frequency in which different areas of the spine were involved is given in Table I. These figures correspond closely to those recorded for previous years [2].

The number of vertebrae involved is shown in Table II. In thirteen of the cases (6.8 per cent.) there was disease of the posterior bony elements. In every case this was in addition to the disease of the vertebral bodies, and is considered to represent extension of the process from the bodies. There was no case of disease of the posterior bony elements encountered in which only one or two vertebral bodies were involved. That

TABLE III

OTHER SITES OF TUBERCULOSIS

Foci of Disease		No. of Cases
Pulmonary		99 (51 per cent.)
Recent or active at spine-fusion operation	25	
Previous, inactive at spine-fusion operation	74	
Other foci		68 (35.4 per cent.)
Bone or joint		28
Genito-urinary		19
Miscellaneous *		21

* Included are six cases of tuberculous tonsils.

such involvement may be an indication of the severity of the disease is suggested by the fact that, although only thirteen (6.8 per cent.) of 192 patients had disease of the posterior bony elements, of the thirty-six who died from tuberculosis the posterior bony elements were involved in six (16 per cent.).

Fifteen patients had two separate foci of disease, and one had three foci. An attempt was made to relate the second focus to the original abscess cavity. A few of these second foci may have resulted from extension of the tuberculosis from the abscess cavity; however, complete roentgenograms were not always available or, if available, were not adequate for evaluation from this standpoint. In reviewing the old x-rays, it was possible in a few cases to detect disease which was originally present but had been overlooked, and which, later becoming evident, was considered as a subsequent second focus.

It can be seen from Table III that over 50 per cent. of the cases had roentgenographic evidence of pulmonary tuberculosis, active either previously or at the time of operation. Although it was intended that patients with active pulmonary disease should not be admitted because of the lack of contagious-care facilities at the Hospital, several with current involvement were unwittingly operated upon. In these patients, the active status of the pulmonary tuberculosis did not become evident until later in the course of the treatment for the spinal disease.

Thirty-five per cent. of the patients had some form of tuberculosis other than or in addition to pulmonary. In some of these patients it was present before the spinal involvement, in others after active disease in the spine, and in some it was noted at the same time. Many had multiple foci of tuberculosis.

In sixty-four patients, or one-third of the total number, the presence of spinal tuberculosis was proved by culture, guinea-pig inoculation, pathological study of tissue, or autopsy. In many patients with other types of tuberculosis, laboratory proof of the disease was obtained but not of the spine lesion. Every patient had a positive tuberculin skin reaction, and all but a few had elevated erythrocyte sedi-

FIG. 1-A
Thoracolumbar tuberculosis.
(*See page 223*)

FIG. 1-B

FIG. 1-C

FIG. 1-D

FIG. 1-E

FIGS. 1-A to 1-G

L. A. A spine fusion from the tenth thoracic to the third lumbar vertebrae was performed at six years of age for diseased vertebral bodies of the eleventh to the third lumbar. Four months later, the fusion area was explored; the fusion was found to be solid, and an additional vertebra above and one below were added to the fused area. The abcess in the right flank was drained preoperatively and continued to drain for twenty-four months following operation.

Fig. 1-A: Before operation.

Figs. 1-B and 1-C: Anteroposterior roentgenograms of the spine when first seen and ten years later. There had been no apparent increase in length of the fused area.

Figs. 1-D and 1-E: Lateral roentgenograms of the spine when first seen and ten years later. The fusion was intact and the disease had been arrested.

Figs. 1-F and 1-G: The patient is in excellent condition, with little deformity, ten years after spine fusion.

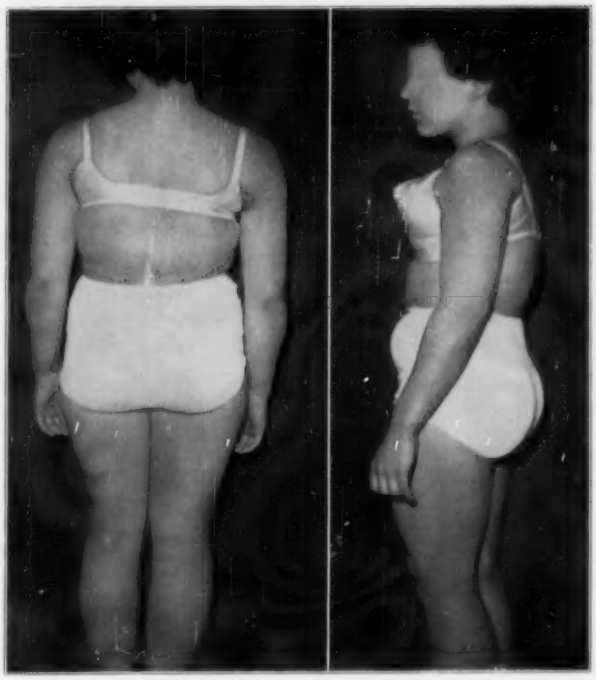

FIG. 1-F FIG. 1-G

mentation rates. Cases which did not exhibit the typical roentgenographic appearance of tuberculosis were excluded from this study. As a routine effort to prove the diagnosis was not made in patients without sinuses or abscesses requiring aspiration or evacuation, it is possible that a few of these had some spinal disease other than tuberculosis.

At the time of operation, fifteen patients had draining tuberculous sinuses. In one of these, the sinus was not from the spine but through a nephrectomy scar, following removal of a tuberculous kidney. Only one patient had a draining sinus directly over the kyphos at the time of surgery.

Treatment

Most patients had spine-fusion operations performed soon after the diagnosis had been made. Those whose general condition was not satisfactory were given a variable period of bed rest and general hygienic care prior to surgery. A routine Hibbs type of spine fusion was done in every case, extra bone being used when needed. The area of fusion included either one or two normal vertebrae above and below the diseased vertebrae. In recent years, accurate localization of the osseous disease by improved roentgenographic technique and by laminograms has shown that the inclusion of only one normal vertebra above and one below the diseased area may be sufficient. In most instances the operation was performed in one stage, although in some cases the fusion was done in two stages, and rarely in three. Most of the patients who had paraplegia at the time of operation had laminectomies performed simultaneously with the fusion. Except for a few patients who, after 1947, received streptomycin for persistent sinuses or for other evidence of the disease, none of these patients received specific antibiotic therapy for tuberculosis. Thus, this group will serve as an excellent control in evaluating the effect of the antituberculosis drugs when a similar series of cases are studied in later years. Our impression at present is that the antibiotic drugs are of great adjuvant value, especially for very ill patients and those with sinuses or large abscesses.

FIG. 2-A

FIG. 2-B

FIG. 2-C

FIG. 2-D

Thoracolumbar tuberculosis.

FIGS. 2-A to 2-F.

A. P. A spine fusion from the ninth thoracic to the first lumbar vertebrae was performed at three and one-half years of age for tuberculosis of the eleventh and twelfth thoracic and the first lumbar vertebrae. Four months later an additional vertebra above and one below were added to the original fusion area.

Figs. 2-A and 2-B: Preoperative roentgenogram and follow-up after eight years. These were made on the same scale and show some increase in length of the fused area.

Figs. 2-C and 2-D: Preoperative and eight-year follow-up lateral roentgenograms. The diseased bodies had fused together and there was no evidence of active disease.

Figs. 2-E and 2-F: Photographs of the patient at follow-up.

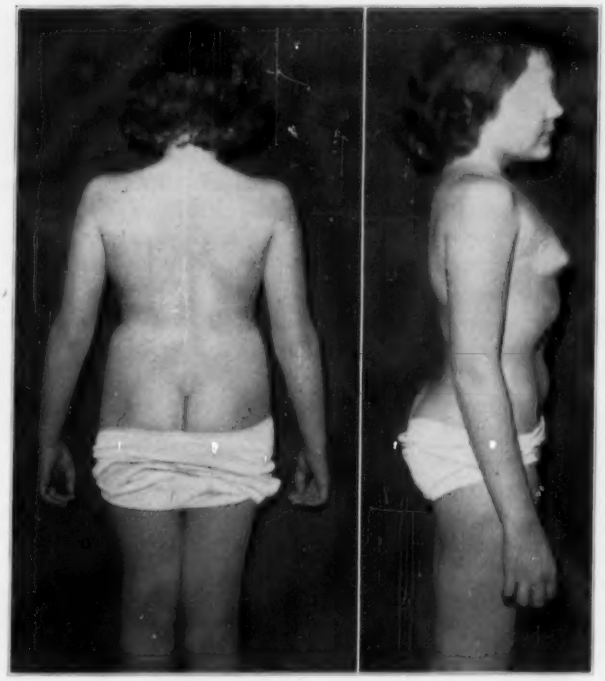

FIG. 2-E FIG. 2-F

Postoperative treatment consisted of the usual general measures. The patients generally were placed in a Taylor brace, or some other type of brace, which had been fitted prior to surgery. Some were immobilized in plaster body jackets when there was a specific reason for doing so, as for coincident tuberculosis of the hip and shoulder. Patients were prescribed for individually concerning the length of time they were to remain in bed following the spine fusion. As a rule, the adults were kept in bed for three months and the children for six months. Patients with extensive involvement or with paraplegia were kept in bed for longer periods.

Complications

Complications were few. There were two deaths in the immediate postoperative period. One was caused by shock in a patient who was found at autopsy to have miliary tuberculosis. The other occurred in an elderly woman after a laparotomy for intestinal obstruction.

There were three pyogenic postoperative wound infections. One of these was serious and resulted in a large granulating wound which required several weeks to heal. The patient, however, attained a solid fusion and arrest of the spinal tuberculosis. In four patients, tuberculous sinuses developed through the operative scar, but all eventually closed.

Subsequent Spine-Fusion Procedures

Additional spine fusions were required by twenty-six patients,—in sixteen patients the original fusion had not included enough vertebrae, in ten patients there was a second focus of the disease. This number does not include those patients operated upon for pseudarthrosis.

Pseudarthrosis

Of the 192 patients, pseudarthrosis occurred in fifty (26 per cent.). Of these, thirty-two had subsequent operations for re-fusion; in eleven patients, two attempts at repair were made, and in one patient, three attempts at re-fusion were made.

No significant change in the rate of failure of fusion according to the number of

vertebrae involved was noted, nor was there any significant relationship between the failure of fusion and the age of the patient.

In analysis of this high incidence of failure of fusion, two factors are prominent. The first is the local effect of the tuberculosis itself, as evidenced by a 46 per cent. incidence of failure of fusion among those patients who had disease of the posterior bony elements and by the fact that in 15.6 per cent. of the patients who had re-fusion operations, the site of the pseudarthrosis was infected with tuberculosis. In such instances, posterolateral fusions or hemifusions would be advisable.

The second and perhaps the more important factor is that the great tendency of the spine toward forward bending produces a distracting strain on the fusion plate until the diseased bodies have made firm bony contact. This is borne out by a number of observations. The pseudarthroses nearly always occur at the apex of the kyphos. There is a high incidence of pseudarthrosis in the lower thoracic and thoracolumbar areas where deformity is an accentuation of the normal curve, which of necessity produces a greater strain posteriorly. Also, the greater the forward bending, the higher was the incidence of failure of fusion. In the lumbar and lumbosacral areas, the normal spine curve is one of lordosis, and the forward bending flattens that curve before actual kyphos formation. In these areas the incidence of pseudarthrosis is distinctly less.

Of interest in respect to this strain on the plate are two patients in whom, because of increasing deformity, their operative sites were explored for failure of fusion, although

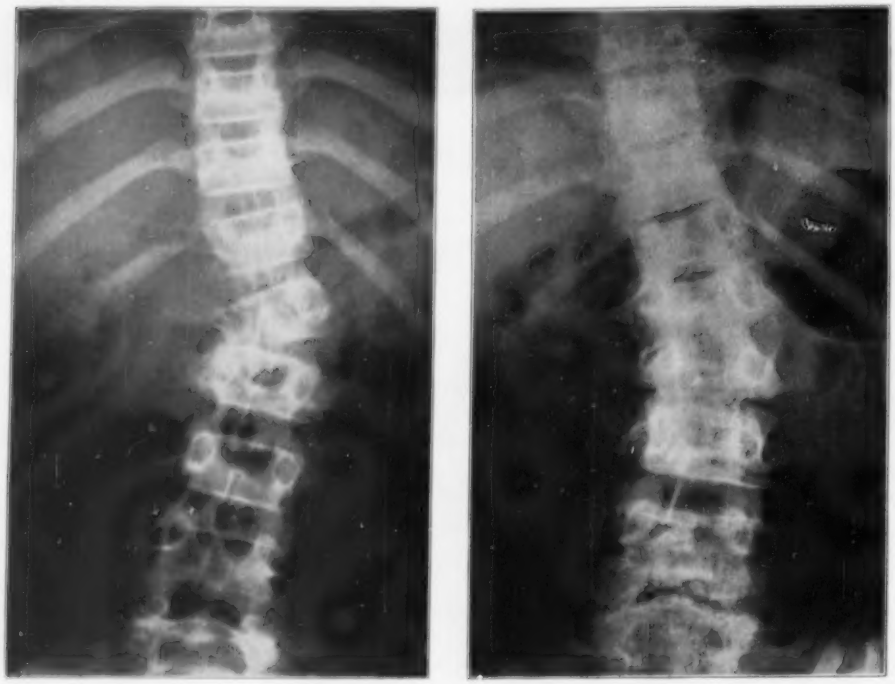

FIG. 3-A FIG. 3-B

Disease of posterior bony elements.

D. S., a twelve-year-old white girl had two foci of tuberculosis, one in the lumbosacral area and the other in the thoracolumbar area, with extension of the disease to the posterior bony elements in the latter.

Fig. 3-A: Anteroposterior roentgenogram shows the involvement of the posterior elements in the thoracolumbar area.

Fig. 3-B: Anteroposterior roentgenogram made six years after spine fusion.

TABLE IV

PREOPERATIVE PARAPLEGIA

Number of Cases	8 cases
Average Age	25.3 years
Average Duration	4.5 years

Surgical Treatment	Results			
	No. of Cases	Partially Relieved	Relieved	Unrelieved
Laminectomy (at time of fusion)	5	0	2	3 (2 died)
Laminectomy (within two months of fusion)	1	0	1	0
Costotransversectomy (after fusion)	1	1 (died)	0	0
Fusion only	1	0	0	1 *
Deaths	3	1	0	2
Causes				
Tuberculous meningitis	1			
Pulmonary tuberculosis	1			
Bronchopleural fistula after costotransversectomy	1			

* Further surgery to relieve paralysis considered futile.

pseudarthroses were not visible in the roentgenograms. After careful search, the operators were completely satisfied that the fusion plates in both were intact. Subsequently, however, pseudarthrosis, which was clearly visible in roentgenograms, developed in both patients; they were operated upon again, and the defects were repaired. In both, it was found that the deformity had continued to increase.

A third patient, upon whom a fusion operation had been performed and a solid fusion had been obtained, was re-admitted following sudden pain without antecedent trauma and with tenderness over the apex of the kyphos. On exploring the fusion, a break in the plate was found, which had the appearance of a fresh fracture and which was probably the result of stress.

Forward bending with resultant increasing deformity does not produce a pseudarthrosis in every instance. In many instances it results only in a bending of a somewhat malleable fusion plate. The sites of fusion in thirteen patients were explored for suspected pseudarthrosis, because of increasing deformity, and in each a solid fusion was found.

Multiple pseudarthroses occurred in twelve patients; ten patients had two pseudarthroses, one had three pseudarthroses, and one had five pseudarthroses. There is incomplete information on multiple pseudarthroses in the patients who died, and it is possible that they may have occurred in a few of these.

Paraplegia

Of the 192 patients, paraplegia developed in twenty-three at some time during the course of the disease, preoperatively or postoperatively. No attempt was made in this study to evaluate the methods of treatment of this complication. The paraplegia occurred as a result of compression of the spinal cord either by tuberculous granulation tissue or by extradural cold abscesses (usually the former) and was not necessarily related to the degree of deformity. Patients who had cord irritation but not complete paraplegia were not included. One-half of the total number of patients with paraplegia died, mostly from tuberculous meningitis.

Paraplegia, preoperative: Eight patients had complete paraplegia at the time of operation, and these are shown in Table IV. The patient who had fusion only with continuing paraplegia had had intermittent paralysis for thirty years, and it was not expected that any relief of paralysis would be obtained by further surgery. This thirty-year period,

FIG. 4-A

FIG. 4-B

FIG. 4-C

Extension of disease from abscess.

E. S. The fifth to the tenth thoracic vertebrae were fused in a white female, twenty-five years old, for tuberculosis involving the bodies of the sixth, seventh, and eighth thoracic vertebrae. Three years later, after the patient had been clinically well for two years, she complained of low thoracic pain; and a second focus was noted at the tenth and eleventh thoracic vertebrae. Spine fusion from the tenth thoracic to the first lumbar vertebrae was performed.

Fig. 4-A: Original anteroposterior roentgenogram showed extensive abscess enclosing the diseased area and a second focus at the tenth thoracic vertebrae which had been overlooked originally.

Fig. 4-B: Original lateral roentgenogram.

Fig. 4-C: Lateral roentgenogram, showing the second focus of tuberculosis at the tenth and eleventh thoracic vertebrae. This second focus was considered to be an extension of the tuberculosis from the original abscess cavity.

TABLE V

IMMEDIATELY POSTOPERATIVE PARAPLEGIA (WITHIN TWO MONTHS)

FOUR CASES

Surgical Treatment	Results			
	No. of Cases	Partially Relieved	Relieved	Unrelieved
Early laminectomy after paralysis appeared	3	1	2	0
Costotransversectomy	2 *	1	1 **	0

* One of these patients had had an early laminectomy.
** Patient died of generalized tuberculosis.

averaged with the others, made the average duration much longer than the actual period in most of the cases.

Paraplegia, immediately postoperative: In four patients paraplegia developed within two months of operation which had consisted of fusion only. Because the paraplegia persisted, laminectomy was performed on three patients. It was found that cord compression was caused by tuberculous granulation tissue in two and by an extradural abscess in the third. On one of these three patients, a costotransversectomy was performed subsequent to the laminectomy; only partial relief was obtained. In the fourth patient, costotransversectomy was the only operative procedure for relief of the paraplegia following fusion. The paraplegia was relieved, but the patient died two years later of widespread dissemination of the tuberculosis. It appears that paraplegia may be precipitated by the spine-fusion operation, and apparently the trauma of the operation was instrumental in producing the paraplegia in these few cases, although it was by no means the sole cause.

Paraplegia, late postoperative: In eleven patients paraplegia developed more than two months after operation. These were the patients in whom there was a progression of the spinal tuberculosis. Failure of fusion occurred in six. In one case cord compression developed eighteen months following the fusion. At laminectomy it was found that the cord was compressed by the fusion mass, which was solid throughout. Four weeks after the laminectomy, the patient showed signs of meningitis and died. At autopsy it was

TABLE VI

LATE POSTOPERATIVE PARAPLEGIA (AFTER AVERAGE TIME OF 2.3 YEARS)

ELEVEN CASES

Surgical Treatment	Results			
	No. of Cases	Partially Relieved	Relieved	Unrelieved
Laminectomy only	9	2	2	5 *
Costotransversectomy	5 **	2	1	2
No treatment	1 †			
Deaths	8	1	2	5
Causes				
Pulmonary tuberculosis	2			
Tuberculous meningitis	3			
Other foci of tuberculosis	1			
Paraplegia	2			

* Patients died.
** Four patients had had laminectomies.
† Intermittent weakness began three years postoperatively. Patient was scheduled to have a laminectomy seven years postoperatively, but did not appear; end result is not known.

FIG. 5-A

FIG. 5-B

FIG. 5-C

FIG. 5-D

Pseudarthrosis.

(*Continued on page 231*)

Figs. 5-A to 5-D: C. A., a white girl, seven and one-half years old, had a spine fusion from the ninth thoracic to the second lumbar vertebrae for disease involving the bodies of the tenth, eleventh, and twelfth thoracic vertebrae.

Fig. 5-A: Original lateral roentgenogram.

Fig. 5-B: Lateral roentgenogram fourteen months after spine fusion. Although the roentgenogram showed an intact spine fusion, the area was explored because of increasing deformity. The fusion was found to be continuous.

Fig. 5-C: Lateral roentgenogram thirty-two months after the original spine-fusion operation. A definite pseudarthrosis was demonstrated, and the degree of deformity had increased. The fusion was again explored, and the defect was repaired. There was no evidence of tuberculosis at the site of the pseudarthrosis.

Fig. 5-D: Lateral roentgenogram seven and one-half years after the original spine-fusion operation. The fusion is solid, but further increase in deformity has occurred, and the body of the eighth thoracic vertebra, which was not included in the area of fusion, has become involved.

FIG. 6-A

FIG. 6-B

Paraplegia.

P. H., a seven-year-old colored girl, was admitted with a complete spastic paraplegia of six weeks' duration. Spine fusion from the fourth to the ninth thoracic vertebrae was performed, but the paraplegia did not clear up. Seven weeks later a laminectomy was performed, and the spinal cord was found to be compressed by tuberculous granulation tissue. Over the following eight months the paraplegia cleared up, with complete recovery resulting.

Fig. 6-A: Original lateral roentgenogram.

Fig. 6-B: Lateral roentgenogram thirteen years after the initial surgery.

found that an extradural abscess had eroded through the meninges. In these patients in whom there was failure to control the disease process, the high rate of pseudarthrosis is significant.

END RESULTS IN THE GROUP OF PATIENTS WHO WERE OPERATED UPON FROM 1931 TO 1947

Deaths

Of the 192 patients, thirty-nine are known to be dead. As mentioned previously, two of these deaths occurred in the immediate postoperative period. Thirty-six died of some form of tuberculosis or a complication related to it. Of the thirty-nine patients, ten (25.6 per cent.) had solid fusions, and the tuberculosis of the spine appeared to be arrested in four, was probably arrested in one, and was apparently subsiding in five.

TABLE VII

KNOWN DEATHS

Causes of Death		No. of Cases
Postoperative		2
Intestinal obstruction two weeks after fusion	1	
Shock in child with miliary tuberculosis	1	
Some form of tuberculosis or complications related to the disease		36
Automobile accident		1
Total		39 *

* The tuberculosis of the spine had been definitely arrested in four of these patients and was probably arrested in one, that is, an estimated operative success in 13 per cent. of the patients who died.

In most of these patients the tuberculosis was truly widespread, 30 per cent. having also active pulmonary infection, 28 per cent. other bone or joint tuberculosis, and 22 per cent. genito-urinary involvement. In general, these patients showed poor resistance to tuberculosis. It is interesting to note that, although there were fewer males than females in this series, two-thirds of the deaths were in male patients. Also noteworthy is the fact that only four of the deaths (11 per cent.) were in patients under ten years of age at the time of operation.

Inadequate Follow-up

Of the group of patients who were followed for less than five years, a few words should be said. Of the fifty-three patients in this group, there are three with absolutely no follow-up information. Of the remaining fifty, ten (20 per cent.) had failure of fusion; when last seen, five of these patients still had pseudarthroses, the other five having been repaired successfully. Seven of the fifty were considered still to have active spinal disease, three of them with failure of fusion. Two are known to have had subsequent operations on the spine at other hospitals, and in both the fusions were solid, and the subsequent surgery was for additional spinal disease. Three of the seven patients were in poor condition when last seen and may now be dead; one had tuberculous pneumonia, another had extensive disease of the posterior bony elements, as well as four other foci of osseous tuberculosis, and the third had draining sinuses and was in poor general condition, although the spine fusion was thought to be solid. In the remaining forty-three patients who were followed less than five years, the disease process had subsided or was subsiding. In the

TABLE VIII

END RESULTS IN PATIENTS WHO WERE OPERATED UPON FROM 1931 TO 1947

Case Groups	No. of Cases		No. of Disease Arrests	
Known results in cases with complete follow-up		139	99	(71 per cent.)
Patients followed for five years or more	100		95	
Patients who died	39		4	
Therefore the disease was known to be arrested in 71 per cent. of the patients.				
Estimated results in the entire group		192	143	(74.5 per cent.)
Patients in whom disease is known to be arrested	99			
Patients followed for less than five years and in whom disease is probably arrested	44			
Therefore disease was probably arrested in 74.5 per cent. of the entire group.				

TABLE IX
DEFORMITY

Effect of Fusion on Deformity		No. of Cases
Reversal of clinical deformity		1 *
Decrease of clinical deformity		2
No increase, or increase of less than 10 degrees		45
Increase ranging from 10 to 30 degrees		20
With pseudarthrosis	9	
Without pseudarthrosis	11	
Increase greater than 30 degrees		11
With pseudarthrosis	8	
Without pseudarthrosis	3	

* Patient had tuberculosis of the lumbosacral vertebrae.

majority of these patients there were no other complications. Pseudarthrosis occurred in only two, and in both the defect was outside of the diseased area.

Patients Living after Five Years

One hundred patients were followed for periods ranging from five to twenty-two years from the time of spine fusion, an average time of 11.4 years. The criteria for arrest of the disease were either partial or complete fusion of the diseased vertebral bodies, complete healing of the diseased bone as shown in roentgenograms, subsidence of the abscesses clinically, complete closure of all sinuses, no pain or tenderness over the fusion area, and general well-being of the patient. In ninety-five of the patients the disease was arrested. Five patients did not fulfill the necessary requirements and are classified as still having active disease, although two of them were actually in good condition and in all probability only require additional time before they, too, can be considered cured. One patient who had progression of paraplegia for seven years following operation was scheduled to enter the Hospital for laminectomy, but he disappeared and has not been heard from.

In fourteen patients there was persistent failure of fusion. In eleven of these the pseudarthrosis was outside of the diseased area. Only three of the fourteen patients still had active disease. Two of the patients with active disease had the pseudarthrosis within the diseased

FIG. 7
Active disease at follow-up.

Fig. 7: G. U., a white male, had onset of the disease at two years of age. He had been treated elsewhere on a Bradford frame for eight and one-half years. At the age of eleven, he had a spine fusion from the second to the seventh thoracic vertebrae, in two stages, for tuberculous involvement of six vertebrae, the eighth thoracic to the first lumbar. He was last seen nine years after the spine fusion, at which time he still had a draining sinus. Roentgenograms at that time showed a solid spine fusion and the diseased bodies fused together, but a sequestrum was present in the center of the diseased area.

FIG. 8-A

FIG. 8-B

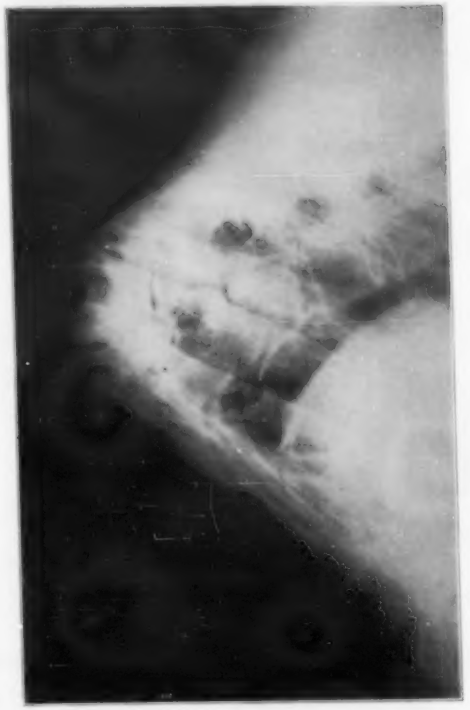

FIG. 8-C

Increase in deformity with a solid fusion.

T. H., a ten-year-old white boy, had a spine fusion of the seventh to the eleventh thoracic vertebrae for tuberculous involvement of the vertebral bodies of the eighth, ninth, and tenth thoracic vertebrae.

Fig. 8-A: Lateral roentgenogram made just before spine fusion.

Fig. 8-B: Lateral roentgenogram made just before the fusion mass was explored for the second time for a possible pseudarthrosis, which it was thought might be present because of the increasing deformity. The fusion was found to be intact both times it was explored.

Fig. 8-C: Lateral roentgenogram thirteen years after the initial surgery. There had been an increase of 85 degrees in the deformity in spite of a solid spine fusion. The patient was well and able to do heavy labor.

TABLE X

LONG-TERM END RESULTS OF SPINE FUSION IN PATIENTS OF THE 1911–1930 SERIES

Analysis of Group		No. of Cases	
Number of patients from 1911 to 1930		817	
Number of patients lost before five years		233	
Number of patients followed until 1940		584	
Deaths before 1940		168	
Number of patients followed from 1940 until 1953		116	
Age at operation	1–48 years		
Average age	11.5 years		
Follow-up	11–41 years		
Average follow-up	22 years		
Number of patients cured		103	(88.7 per cent.)
Number of patients with active disease		6	
Number of patients with paraplegia and still living *		3	
Number of deaths since January 1940		7	

* Two of these patients have active disease.

area. In the third patient with a failure of fusion within the diseased area, the spinal tuberculosis had been arrested.

Persistent paraplegia was present in four patients. Two of these patients still had active disease, but in the other two the disease had been arrested.

FIG. 9-A

FIG. 9-B

Growth of the vertebral bodies in the fusion area.

J. L., a twenty-month-old girl, had a spine fusion from the tenth thoracic to the fourth lumbar vertebrae for tuberculosis involving the bodies of the first and second lumbar vertebrae.

Fig. 9-A: A lateral roentgenogram two years after spine fusion.

Fig. 9-B: Lateral roentgenogram fourteen years after spine fusion. There has been an increase in size of the vertebral bodies and narrowing of the disc spaces. The patient was well clinically, and her trunk was not noticeably shortened. Her height was sixty-two inches.

FIG. 10-A

FIG. 10-B

FIG. 10-C

Ideal case with decrease in clinical deformity.

M. R., a white boy, two and one-half years old, had a spine fusion from the seventh to the twelfth thoracic vertebrae for tuberculous involvement of the bodies of the ninth and tenth thoracic vertebrae.

Fig. 10-A: Lateral roentgenogram made just prior to spine fusion.

Fig. 10-B: Lateral roentgenogram fifteen months following spine fusion.

Fig. 10-C: Lateral roentgenogram five and one-half years after surgery.

FIG. 10-D

FIG. 10-E

FIG. 10-F

Fig. 10-D: Lateral roentgenogram thirteen years after spine fusion.

Figs. 10-E and 10-F: Anteroposterior roentgenograms before fusion and after thirteen years, made on the same scale, show considerable increase in the length of the fused area.

Table VIII gives the final results in 139 patients for whom a complete follow-up was available, as well as the estimated results for the total number of cases (192) of spinal tuberculosis treated during the years 1931 to 1947.

Deformity

Because some of the original x-rays had been destroyed, a study of the entire group could not be made. However, of the 100 patients who were followed for five years or longer, there were complete roentgenograms in seventy-nine. These were studied carefully, and by comparing the original with the follow-up roentgenograms certain observations could be made.

Deformity was far greater in the children with spinal tuberculosis. The deformity was greater in those patients in whom the thoracic spine was the site of the disease. As noted in Table IX, the presence of a solid fusion may not prevent increasing spinal deformity. The amount of deformity was directly proportional to the degree of destruction of the vertebral bodies. In none of the patients did the fusion hold apart the diseased vertebrae for a prolonged period of time. The effect of the fusion in most of the cases was to stop the progress of the disease, and thereby keep the tendency toward increasing deformity at a minimum.

Subsequent Growth in Children

There has been some doubt concerning the effects of spine fusion on growth in children. Following the fusion, the normal vertebral bodies included in the fusion area develop normally and grow to nearly the same size as the vertebral bodies outside the area of arthrodesis. Within the fusion area they encroach upon the disc spaces and, in a sense, appear to grow at the expense of the intervertebral discs. These become narrowed to the point of being barely visible.

There may be a tendency toward lordosis, and in one case, after fusion, there was actual reversal of the clinical deformity.

FIG. 11-A
(*See page 239*)

This phenomenon is a desirable one, especially in the thoracic and thoracolumbar areas. In two patients this tendency toward lordosis decreased the original clinical deformity, and in many others it restricted the amount of deformity which was taking place as a result of the collapse of the diseased bodies.

The fused area does increase in length, but to a variable degree. The short trunks seen in full-grown patients who had had spinal disease in childhood are due largely to the destruction and collapse of diseased vertebral bodies and to the resultant forward bending of the spine, although the fusion itself does exert a variable retarding influence on longitudinal growth of the spine.

The loss of spinal motion in the fused area was not a handicap in any of the patients. Compensatory mobility in the unfused areas, even when the entire lumbar spine was fused, served the patients well.

LONG-TERM END RESULTS IN THE GROUP OF PATIENTS WHO WERE OPERATED UPON FROM 1911 TO 1930

Since January 1940, when Walker E. Swift reported a study of the 817 patients who were operated upon from 1911 to 1930 inclusive, 116 of these (14 per cent.) have been re-examined by members of the Staff or are known to have died during the period from January 1940 to June 1953. Age at operation was from one year to forty-eight years, and the average was eleven years. The time of end-result examinations varied from eleven to forty-one years, averaging twenty-two years. This group represents truly long-term end results.

FIG. 11-B

FIG. 11-C

The longest follow-up.

F. S. had a spine fusion performed in February 1912 for tuberculosis involving the mid-thoracic vertebral bodies.

Fig. 11-A: Lateral roentgenogram made forty-one and one-half years after spine fusion. The old diseased bodies were fused together and there was no x-ray evidence of active disease.

Fig. 11-B: Lateral view of the patient's back, showing the deformity of the spine.

Fig. 11-C: The patient, who was in the Hospital for a knee injury, was healthy, and her back was completely asymptomatic.

Seven patients died after 1940, the length of time after operation varying from fourteen to twenty-eight years. The cause of death was not known in four cases. One patient had had gastric hemorrhages over a period of two years before death. One died suddenly twenty-six years postoperatively; clinical and roentgenographic examination two years before had demonstrated cure of the spine lesion. Two patients had had paraplegia of many years' duration, but it is not known whether the vertebral disease was active or not at the time of death or shortly before. Of the other three patients, one died of a heart condition eighteen years after operation; roentgenograms made six years before had shown fusion of the previously involved vertebrae and subsidence of disease. Two patients died eighteen and twenty years postoperatively of active tuberculosis,—of the genito-urinary system in one and of the meninges in the other. Autopsy in the latter case showed that all the diseased vertebral bodies had fused together but that there was invasion of the meninges causing tuberculous meningitis.

Clinical or roentgenographic evidence of the continued activity of disease was present in six patients. In five, this consisted of persistent sinuses and abscesses; in one of these

patients there was paraplegia as well, although roentgenograms made eighteen years after operation showed apparently solid fusion and subsidence of disease. In the sixth patient, paraplegia was present, and the question of disease activity could not be ascertained by the roentgenologist. This case, therefore, has been classified as one with possibly continued activity.

Good clinical condition and roentgenographic evidence of complete subsidence of the spinal disease were found in 103 cases (88.6 per cent.) of the 116. The longest known result, in a case followed for forty-one years, is in this group. The patient was operated upon in 1912 at the age of nine years in Dr. Hibbs' fourth fusion operation. She is in excellent health and has an asymptomatic spine; roentgenograms show complete subsidence of the previous thoracic tuberculosis. One of the patients in this group was examined twenty-two years after operation and found to be completely free of symptoms; the patient was leading an active life but had a residual partial paraplegia with hyperactive reflexes and a stiff right lower extremity. Cord compression had been present before the operation. It subsided subsequently but reappeared eight months later. A laminectomy was performed two years postoperatively through a solid fusion plate, and in eight years the patient had made a fair recovery from the paraplegia. Roentgenograms showed a solid fusion, healthy bones, and bony ankylosis of what remains of the previously affected vertebral bodies; it seems reasonable to include the case in this group.

CONCLUSIONS

1. Spine fusion is a safe and effective means of obtaining long-standing clinical and roentgenographic subsidence of disease in a large percentage of patients. The results are somewhat better in children.

2. To be most efficacious, spine fusion should be performed early in the course of the disease, before the development of major abscesses or of paraplegia, but it is still of great value and should not be withheld even after such complications have developed.

3. Failures are due to pseudarthroses or inadequate areas of fusion and also may occur in instances of marked virulence of the infecting organism or in overwhelming disease in individuals with low resistance.

4. Tuberculosis is a general disease of which the spine lesion is a local manifestation; this fact should not be overlooked in the treatment of the individual. Streptomycin and the newer isonicotinic acid hydrazides appear to have a beneficial effect on the disease itself, and also are of great adjuvant value in the treatment of the local lesion and its complications of sinuses and abscess formation.

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DISCUSSION

Dr. David M. Bosworth, New York, N. Y.: This paper by Dr. Hallock and Dr. Jones is an excellent factual, statistical study. As such, we have no question as to the conclusions indicated. At times, however, facts give way to opinion. At such times we would occasionally differ with them, not so much as to basic premises but as to the extent of treatment indicated.

They have stated that a Hibbs-type fusion could be done, reinforced by extra bone "where necessary". We feel that reinforcement is *always* necessary except in the very young child.

(*Continued on page 374*)

END RESULTS IN THE TREATMENT OF SARCOMATA OF THE SOFT SOMATIC TISSUES *

BY GEORGE T. PACK, M.D., NEW YORK, N. Y.

From the Mixed Tumor Service, Memorial Cancer Center, New York

During the last quarter of a century, all sarcomata of the soft somatic tissues at the Memorial Cancer Center have been subject to the group judgment and treatment of the Mixed Tumor Service. This opportunity has permitted a survey of the largest group of these sarcomata ever studied and an application of principles of treatment under uniform guidance. The data presented here are therefore unique for several reasons. They are not a collection of cases from various sources having in common only a uniform histological diagnosis. The evolution in principles of surgical and radiation treatment over the years has been the result of collective thought and efforts by the few members of a single hospital department. The unusually large number of cases in each histogenetic group permits study of the natural history of each type, and the period of twenty-five years affords an adequate time for follow-up.

Sarcomata of the soft somatic tissues comprise 0.7 per cent. of all admissions to the Memorial Hospital Clinics, 0.8 per cent. of all malignant tumors, 1.01 per cent. of all malignant tumors in males, 0.6 per cent. of all malignant tumors in females, and 6.58 per cent. of all malignant tumors occurring in patients under twenty-five years of age.

BIOPSY OF SOFT-PART TUMORS

The orthodox biopsy with punch forceps or scalpel is suitable only for those soft somatic tumors which are ulcerated or which are fungating through the skin. We prefer to use an endothermic loop with bipolar coagulating current because of the putative advantages of lessening the dangers of infection, hemorrhage, or dissemination.

Surgical excision of the tumor in its entirety is the most practical solution for identification if the tumor is small. The total specimen is thus available for immediate frozen section without the hazard of surgical trauma. If the small tumor is benign, the excisional biopsy is sufficient. If it proves to be malignant, the surgeon can deliberately plan for the more radical dissection or amputation and the patient does not suffer from the slight delay.

Aspiration biopsy has been a safe procedure in the author's hands. The following technique is recommended: The suprajacent skin is locally anaesthetized and punctured with a bistoury so that the biopsy needle will not incorporate epidermal cells in its lumen and thus confuse the diagnosis. While the tumor is gently immobilized by one hand, a sharp 17-gauge needle is thrust down to the neoplasm. Then a Record syringe is attached, and the needle is advanced into the tumor while steady strong suction is maintained. This procedure is intended to secure a plug of representative tumor tissue within the bore of the needle. The needle is then partly withdrawn while suction is maintained to disengage the tumor plug. In order not to scatter cells along the needle pathway, the syringe is detached before the needle is withdrawn. The specimen is smeared between slides, fixed, and stained. The pathologist who examines the biopsy specimen needs considerable experience in cytodiagnosis, as well as a cooperative spirit. The critics of aspiration biopsy are too specific in their demands of the method. The procedure is successful if it permits a differential diagnosis between inflammatory and neoplastic tissues, or, in the case of tumor, between the benign and the malignant variety. Deter-

* Read at the Annual Meeting of The American Orthopaedic Association, White Sulphur Springs, West Virginia, June 21, 1951.

TABLE I

CLASSIFICATION OF SOFT-PART SOMATIC TUMORS *

Type of Tissue	Benign Tumors	Malignant Tumors
1. Fibrous tissue	a. Fibroma b. Keloid c. Dupuytren's contracture; palmar and plantar fibromatosis d. Peyronie's disease of penis; chronic fibrosing cavernitis e. Desmoid tumor of abdominal wall (desmoma) f. Progressive fibrosing myositis (Meyenburg's disease) g. Dermatofibrosarcoma protuberans	a. Fibrosarcoma b. Dermatofibrosarcoma protuberans
2. Undifferentiated mesenchyme	a. Myxoma b. Mesenchymoma	a. Myxoma b. Mixed-cell sarcoma (mesenchymoma)
3. Heterotopic bone and cartilage	a. Myosotis ossificans	a. Osteogenic sarcoma b. Chondrosarcoma
4. Adipose tissue	a. Lipoma (solitary and multiple) b. Congenital diffuse lipomatosis	a. Liposarcoma
5. Blood and lymph vessels	a. Hemangioma b. Systemic angiomatosis c. Rendu-Osler-Weber's disease d. Neuro-angiomatous syndromes e. Lymphangioma f. Cystic hygroma g. Glomus tumor h. Hemangiopericytoma	a. Angiosarcoma b. Lymphangiosarcoma c. Angio-endothelioma d. Kaposi's idiopathic sarcoma e. Granulation-cell sarcoma f. Hemangiopericytoma
6. Lymphatic and reticulo-endothelial tissue	?	a. Malignant lymphocytoma b. Reticulum-cell sarcoma c. Brill-Symmers disease; giant follicular lymphoma d. Mycosis fungoides e. Plasmocytoma f. Hodgkin's disease
7. Synovial mesothelium	a. Giant-cell tumor of tendon sheath b. Synovial xanthoma c. Hypertrophic arborescent synovioma of joints	a. Malignant synovioma (synovial sarcoma)
8. Smooth muscle	a. Leiomyoma b. Dermatoleiomyoma	a. Leiomyosarcoma
9. Striated muscle	a. Rhabdomyoma b. Granular-cell myoblastoma	a. Rhabdomyosarcoma
10. Peripheral nerves	a. Neurofibroma b. Neurofibromatosis (von Recklinghausen's disease) c. Schwannoma (neurilemoma or perineurial fibroblastoma) d. Ganglioneuroma e. Paraganglioma (benign) 1. Carotid-body tumor 2. Pheochromocytoma 3. Carcinoid tumor ?	a. Malignant schwannoma b. Neurosarcoma c. Neurocytoma d. Paraganglioma (malignant) 1. Carotid-body tumor 2. Pheochromocytoma 3. Carcinoid tumor ?

* This classification was modified from the working table adopted by the Panel on Soft-Part Tumors, Dr. Arthur Purdy Stout, Moderator. *In* Proceedings of the First National Cancer Conference, American Cancer Society and The National Cancer Institute, U. S. Public Health Service, 1949.

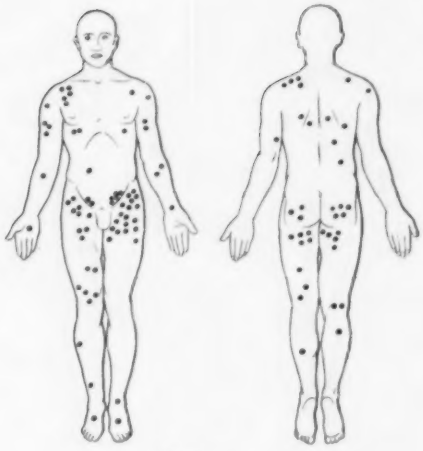

FIG. 1

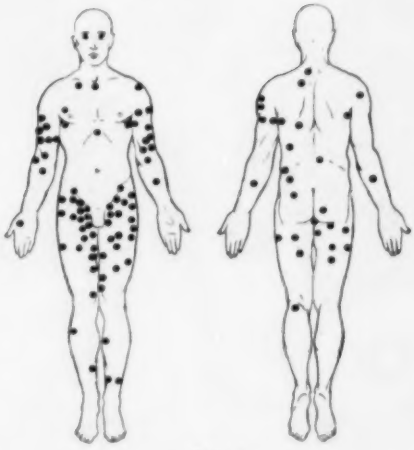

FIG. 2

Fig. 1: Regional distribution of liposarcoma.

Fig. 2: Regional distribution of rhabdomyosarcoma. (Reproduced by permission of The C. V. Mosby Company from *Surgery*, 32: 1039, 1952.)

mination of the histogenesis of the tumor usually can be done after detailed examination of the surgical specimen, but sometimes a positive diagnosis of neurilemoma, synovioma, *et cetera* has been made. It is occasionally difficult or even impossible to secure a satisfactory biopsy specimen by aspiration of a hard desmoplastic tumor such as some types of fibrosarcoma. We completely disregard negative findings in aspiration biopsy and do not permit them to influence the choice of subsequent treatment, but a positive biopsy has always been reliable. In 15 per cent. of all soft somatic sarcomata, aspiration biopsy will not secure tissue representative of the true nature of the neoplasm.

Some surgeons have not hesitated to recommend and employ formal incisional biopsies of the more deeply located tumors. Their advice has been to suture the incised capsule or pseudocapsule of the tumor under strictly aseptic care and to close the overlying muscles, fascia, and skin without drainage. The author has witnessed tragic sequelae complicating the use of this technique. Because almost uncontrollable hemorrhage has followed incision into certain highly vascular sarcomata, packing has unwisely been used to stop such bleeding. If an interval has been permitted to elapse before the sarcoma is completely excised, fungation and great growth activation have occurred through such injudicious incisions. If a formal incisional biopsy is necessary, the following precautions should be observed. On an extremity, a tourniquet is placed above the tumor. After the biopsy the tourniquet remains in place while the surgeon awaits preparation and analysis of the frozen section. If the tumor proves to be benign or a sarcoma of low-grade malignancy, a local excision or radical dissection is immediately completed. If the report classifies the lesion as a sarcoma with invasive propensities and the regional anatomy is not conducive to a local radical removal, an amputation of the extremity is done proximal to the tourniquet which has been left in place.

DO BENIGN SOMATIC TUMORS EVER BECOME MALIGNANT?

The majority of soft-part sarcomata originate as such. As a general rule the benign somatic neoplasms seldom become malignant and therefore offer little cause for apprehension. However, it cannot be stated categorically that a benign soft-part tumor is invariably safe, because malignant transformation does and can occur. The more important problem is the diagnostic riddle whether a specific tumor in a patient is benign or malignant.

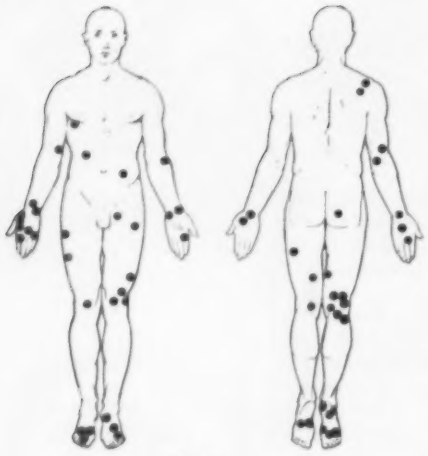

FIG. 3

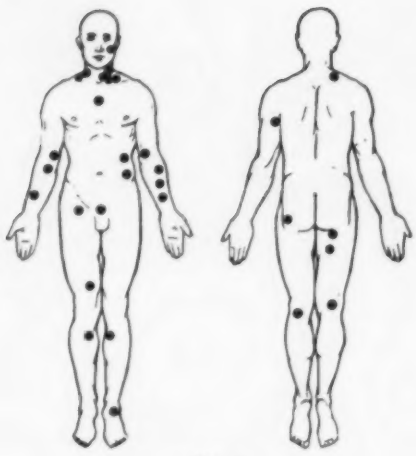

FIG. 4

Fig. 3: Regional distribution of malignant synovioma (synovial sarcoma). (Reproduced by permission of The C. V. Mosby Company from *Surgery*, 28: 1055, 1950.)

Fig. 4: Regional distribution of malignant neurilemoma. (Reproduced by permission from *The American Journal of Surgery*, 82: 420, 1951.)

Unencapsulated fibromata of fascia and subcutaneous tissues often grow diffusely and sometimes are incompletely excised because of the difficulty in determining the peripheral limits of growth. With successive recurrences, the tumor becomes increasingly cellular, anaplastic, and invasive until ultimately it can be properly labeled as fibrosarcoma. Desmomata of the abdominal wall or elsewhere which have been classified as benign by competent pathologists have recurred with subsequent pregnancies and in a few instances visceral metastases have developed.[5]

In 10 per cent. of the patients in this series with von Recklinghausen's disease of the peripheral nerves (neurofibromatosis) malignant neurilemomata have developed. The degree of malignancy is low and the cure rate is high for these sarcomata which occur in neurofibromatous patients, in contrast to the poor prognosis in those cases in which the malignant neurilemoma first develops as such. The author has had some patients with multicentric origin of these sarcomata of nerve sheaths, sometimes with many years elapsing between their appearance.[18]

Benign tumors of vascular origin (hemangiomata and lymphangiomata) almost never undergo malignant changes. Three patients in this series, however, acquired angiosarcomata (malignant angio-endotheliomata) apparently originating in pre-existing benign vascular tumors. The time intervals elapsing between the recognition of the benign tumor and identification of the angiosarcoma were eighteen, twelve, and four years respectively. Two of the three precursory benign tumors were lymphangiomata. All three patients had received x-ray therapy for the benign angiomata.

Synovial sarcomata have apparently developed from benign, encapsulated, solid tumors of synovial membrane, but in our experience we have not been able to trace any malignant synovioma as originating from the benign giant-cell tumor of tendon sheath or the benign arborescent tumor occurring around joints.

Does a lipoma ever become a liposarcoma? The benign lipoma is one of the most common tumors and the liposarcoma is admittedly of rare occurrence. One might therefore conclude that the hazard of malignancy in any one lipoma would be slight indeed. Yet the transformation does occasionally take place, so that the question must be answered in the affirmative. Lipomata achieving considerable bulk sometimes undergo xanthomatous and myxomatous degeneration; in these foci liposarcoma can and does originate. On

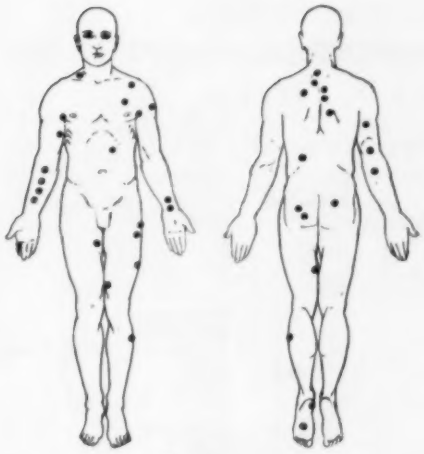

FIG. 5

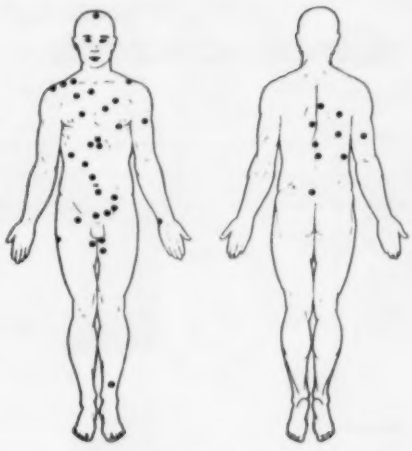

FIG. 6

Fig. 5: Regional distribution of fibrosarcoma. (Reproduced by permission of The C. V. Mosby Company from *Surgery*, 31: 453, 1952.

Fig. 6: Regional distribution of dermatofibrosarcoma protuberans. (Reproduced by permission of the American Medical Association from *A.M.A. Archives of Surgery*, 62: 396, 1951.)

one occasion the author removed a huge benign lipoma, in the very center of which Dr. Ewing discovered a tiny, hard, encapsulated malignant neurilemoma.

REGIONAL DISTRIBUTION OF SOFT-PART SARCOMATA

The localization of various types of sarcomata is not absolutely specific and is not statistically dependent, in the quantitative sense, on the proportion of any tissue in a given region. However, an analysis of this large series does reveal that predilections seem to exist for some sarcomata in certain regions. A knowledge of these regional distributions is of considerable importance, enabling the clinician to surmise with some accuracy the histogenetic type of tumor with which he is concerned. For example, Kaposi's idiopathic hemorrhagic sarcoma usually begins in multicentric fashion on the feet, occasionally on the hands, rarely on the penis or in the oral mucosa. Liposarcomata favor the pelvic and shoulder girdles, as do the benign lipomata. Malignant synoviomata occur preponderantly on the hands and feet and in the neighborhood of the knees. Rhabdomyosarcomata are found in greatest abundance in the upper portions of the thigh and arm. The pure fibrosarcomata are the most generalized in distribution, with slight regional frequency in the shoulder and thigh, whereas dermatofibrosarcoma protuberans develops in the majority of cases on the trunk. The malignant neurilemoma is encountered frequently in the neck and in the distal parts of the extremities, that is, the forearm and leg.

SURGICAL TREATMENT OF SARCOMATA OF SOFT SOMATIC TISSUES

In any given case of sarcoma of the soft somatic tissues, the surgeon, in arriving at a choice between amputation and radical surgical dissection, must consider certain factors which we have repeatedly emphasized, — namely, the histogenesis of the tumor, its degree of malignancy, the fixity or mobility, the original location, the primary or recurrent status, the presence of regional and distant metastases, and finally the experience and judgment of the operator.

The first step in treatment is the establishment of a correct histological diagnosis, if this be possible. The original surgical specimen should be obtained for selective staining and analysis, if the sarcoma under treatment is recurrent. If the sarcoma is primary and previously untreated, and if aspiration biopsy is not confirmative, formal incisional biopsy

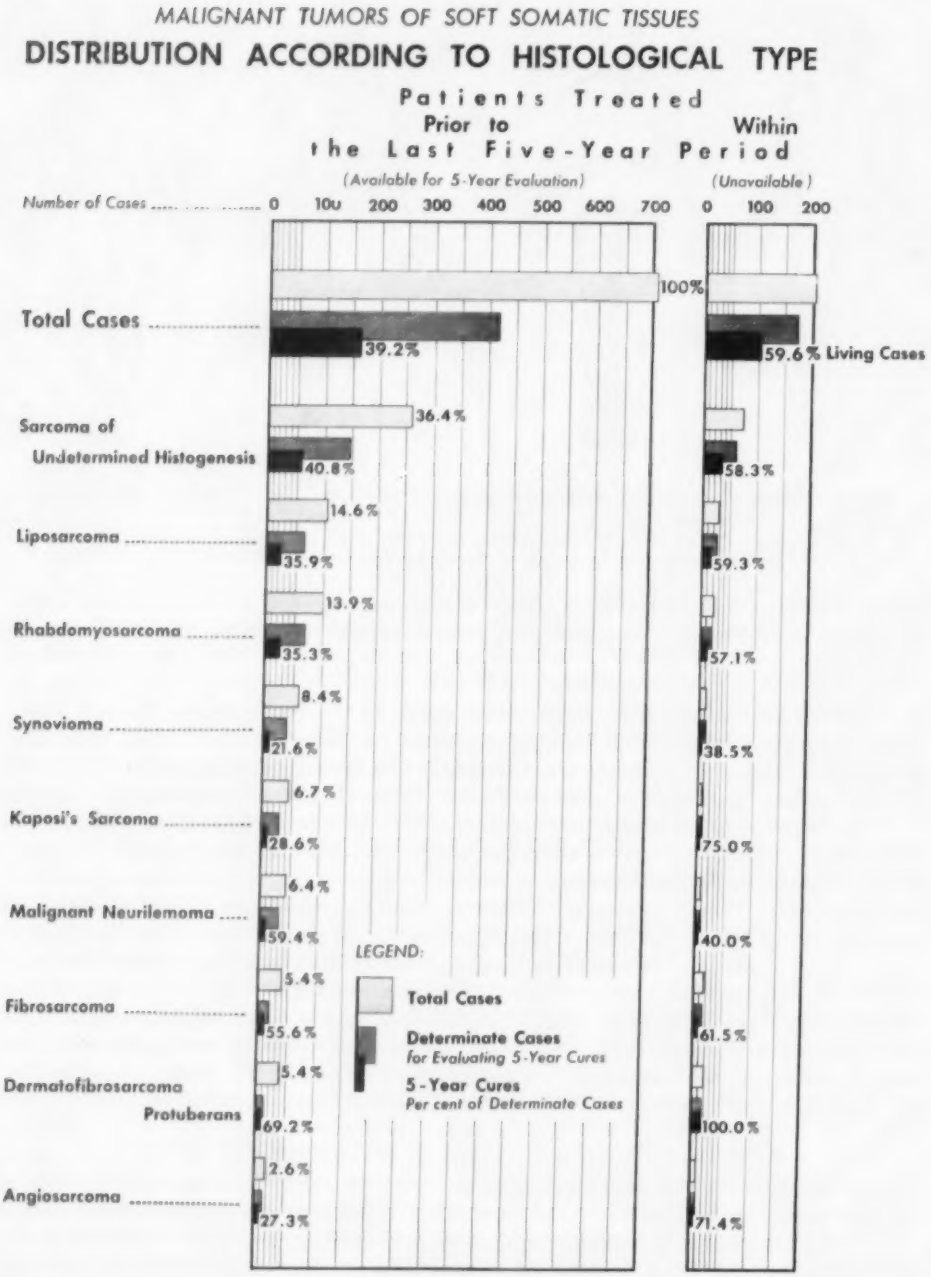

FIG. 7

as the only recourse must be undertaken. An immediate microscopic diagnosis is therefore available, if frozen-section analysis is done, and the surgeon may proceed immediately with either surgical dissection or amputation. The behavior patterns of sarcomata of different histogenetic types should be generally known by the surgeon in order that he may plan his course of action, — such as the tendency for multicentric origin of rhabdomyo-

MALIGNANT TUMORS OF SOFT SOMATIC TISSUES

END-RESULTS IN RELATION TO LOCATION OF THE TUMORS

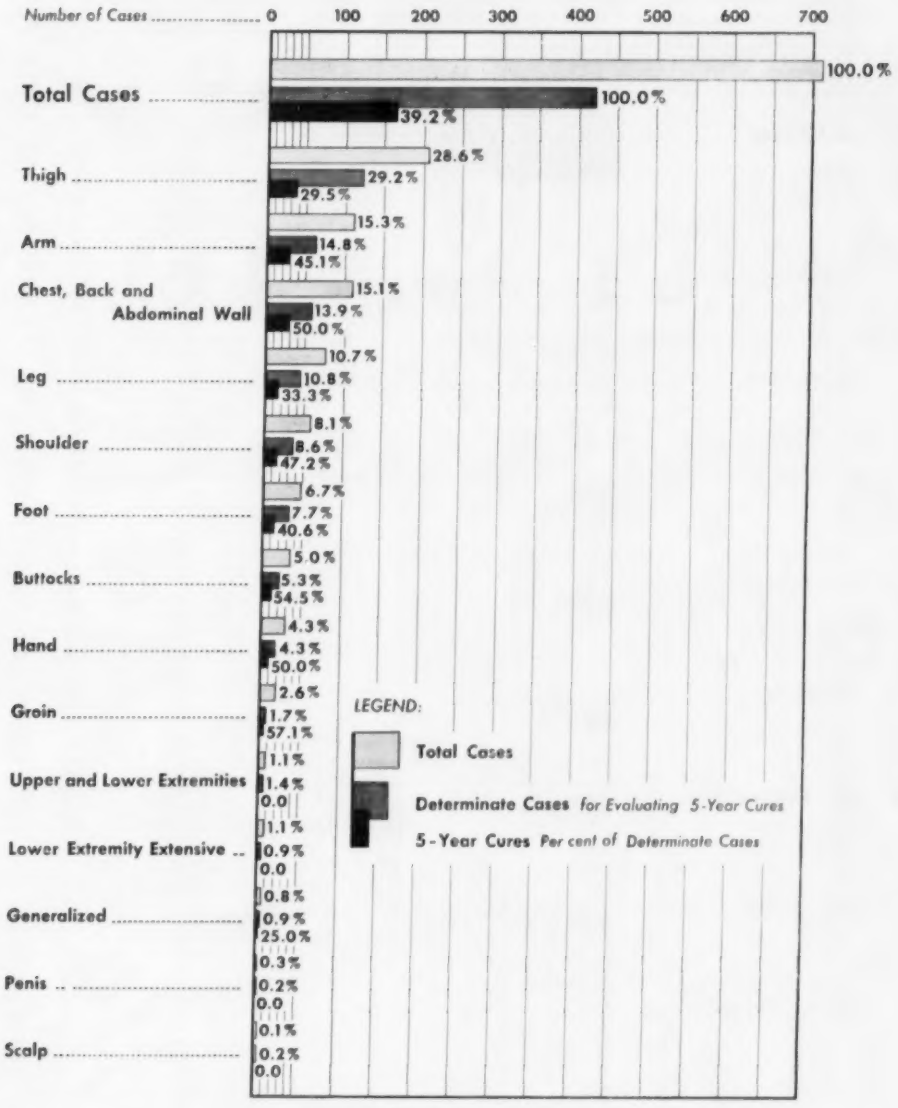

FIG. 8

sarcomata, the frequency of metastases to regional lymph nodes by malignant synovioma (20 per cent.), the tremendous hazards of local recurrence occurring so frequently with fascial sarcomata, the habit of angiosarcomata to metastasize early to lungs, and the phenomenal radiosensitivity of embryonal liposarcomata. It is a wise precaution to secure consent for amputation prior to any operation on sarcoma of the extremities, because at the time of attempted surgical dissection the surgeon may find that the local extent and invasiveness of the tumor precludes the possibility of cure, and amputation should not be delayed to a subsequent date.

MALIGNANT TUMORS OF SOFT SOMATIC TISSUES

CURABILITY IN RELATION TO THE AGE OF THE PATIENT

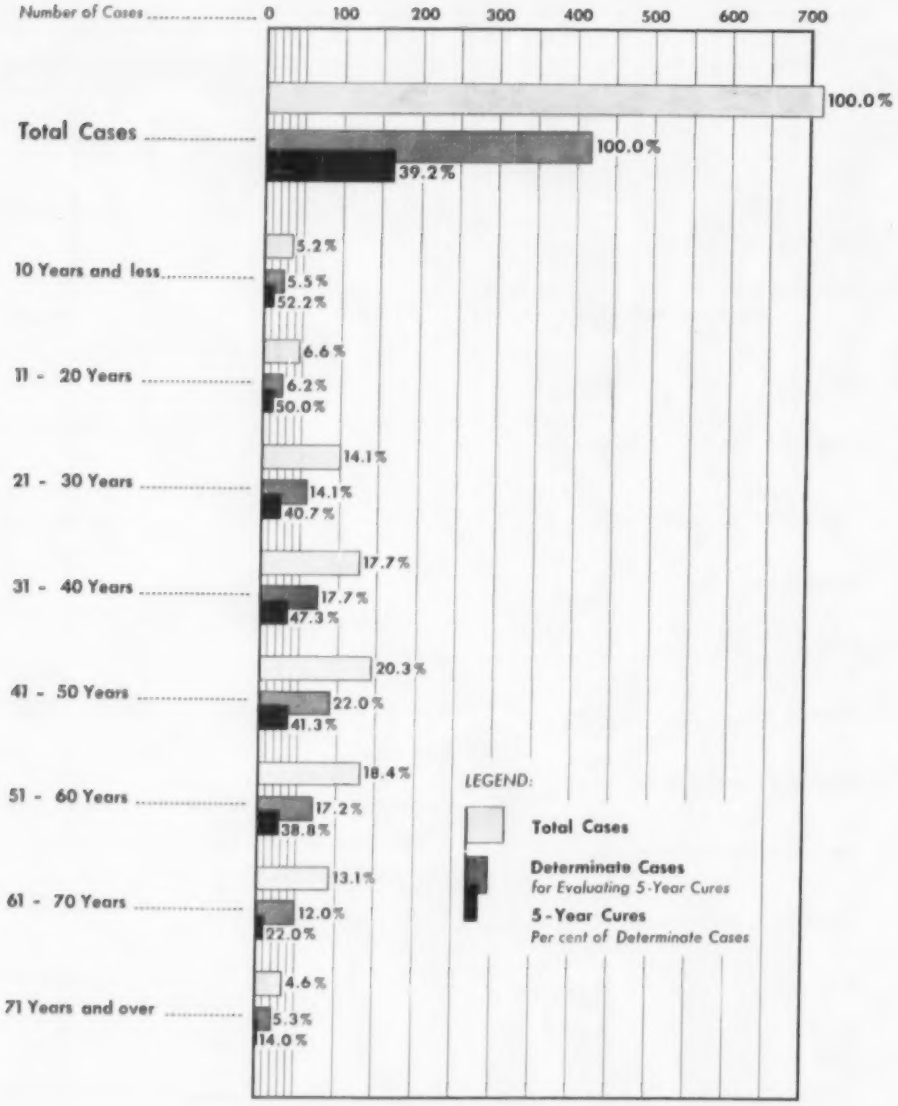

FIG. 9

Sarcomata are feared because of their reputed tendency to metastasize after slight trauma; this tendency is attributed to their vascularity and cellularity. If local removal of such a tumor is to be done with preservation of the extremity, enucleation is never practised. These tumors are usually not encapsulated, as the covering is a pseudocapsule composed of condensation of fibrous components of the neoplasm itself. The apparent encapsulation of the tumor offers a great temptation for simple enucleation, as in some instances it is easily dislodged from its tumor bed. Such a temptation should be resisted,

MALIGNANT TUMORS OF SOFT SOMATIC TISSUES

TYPE OF TREATMENT IN RELATION TO FIVE-YEAR SURVIVAL WITHOUT CANCER

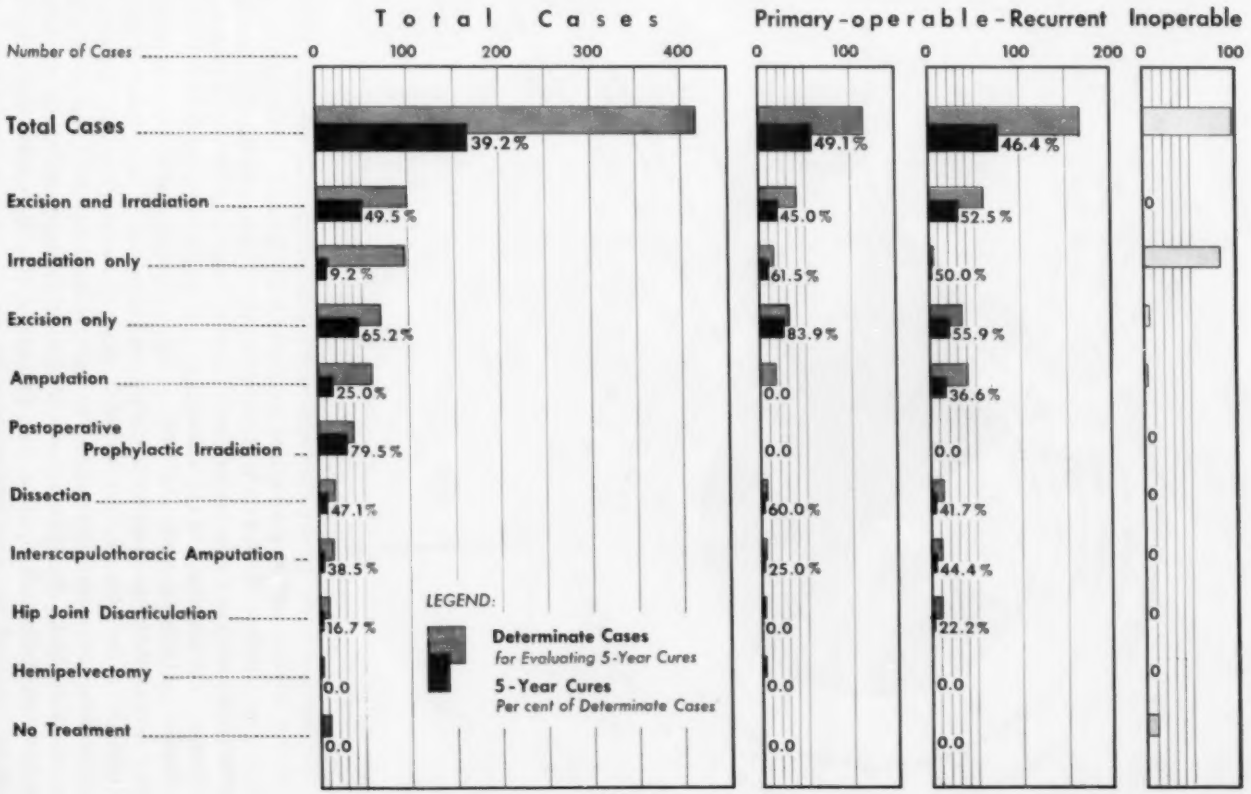

FIG. 10

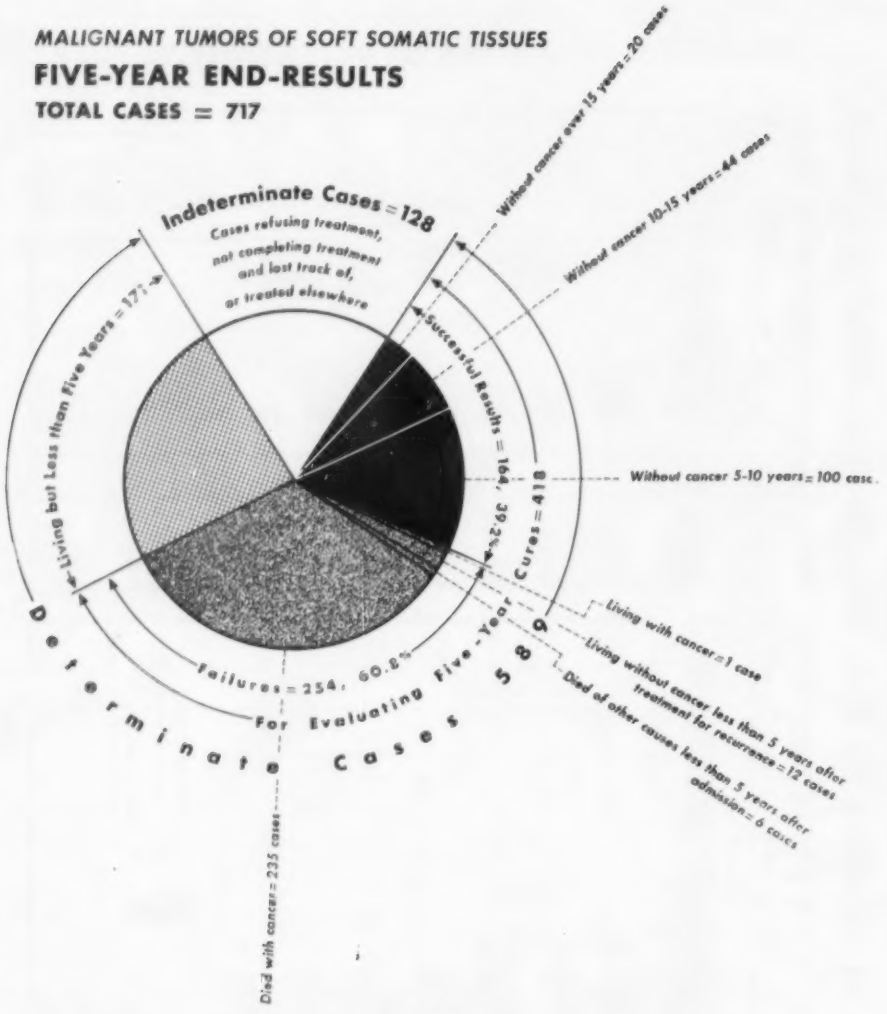
MALIGNANT TUMORS OF SOFT SOMATIC TISSUES
FIVE-YEAR END-RESULTS
TOTAL CASES = 717
Indeterminate Cases = 128
Cases refusing treatment, not completing treatment and lost track of, or treated elsewhere
Without cancer over 15 years = 20 cases
Without cancer 10-15 years = 44 cases
Without cancer 5-10 years = 100 cases
Successful Results = 164, 39.2%
Cures = 418
Living but Less than Five Years = 171
Living with cancer = 1 case
Living without cancer less than 5 years after treatment for recurrence = 12 cases
Died of other causes less than 5 years after admission = 6 cases
Failures = 254, 60.8%
For Evaluating Five-Year Results
Determinate Cases = 589
Died with cancer = 235 cases

FIG. 11

and the operation should be planned to be of a radical character, with removal of all of the tissues surrounding the sarcoma. Retraction by the assistant should always be away from the tumor so that the neoplasm proper is not compressed. If the radical dissection is undertaken for a sarcoma of the extremities, the operation is done with a tourniquet applied superior to the upper limits of the tumor; the tourniquet remains in place during the execution of the biopsy and while the surgical dissection is being done. If the radical local removal of the sarcoma fails, either because of the invasiveness of the tumor or because it becomes increasingly evident as the operation proceeds that such a local removal would be futile, the amputation is performed immediately, above the tourniquet which had been previously applied. This precaution is of theoretical advantage in preventing metastasis of tumor cells dislodged in the course of surgical manipulation. Careful study of the excised surgical specimen may reveal intravascular tumor thrombi, which conceivably could be easily disseminated by the trauma incident to the operation. Masses removed from the trigonum femorale and preoperatively diagnosed as metastases to

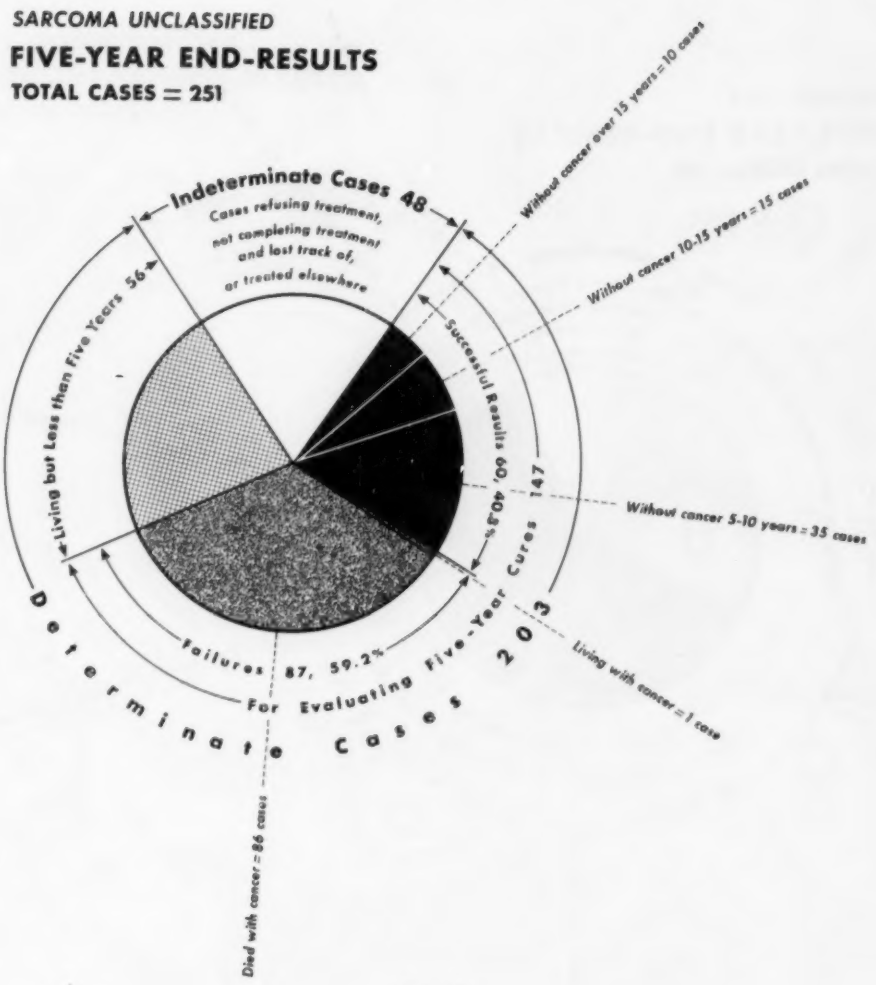
SARCOMA UNCLASSIFIED
FIVE-YEAR END-RESULTS
TOTAL CASES = 251
Indeterminate Cases 48
Cases refusing treatment, not completing treatment and lost track of, or treated elsewhere
Living but Less than Five Years 56
Without cancer over 15 years = 10 cases
Without cancer 10-15 years = 15 cases
Successful Results 60.4%
147
Without cancer 5-10 years = 35 cases
Living with cancer = 1 case
203
For Evaluating Five-Year Cures
Determinate Cases
Failures 87, 59.2%
Died with cancer = 86 cases

FIG. 12

lymph nodes have occasionally been found to represent tumor thrombi present in the larger venous channels. The author's associate, Dr. Robert Booher, in recognition of this danger of disseminating tumor thrombi while performing a local removal of such a tumor, formulated a plan for routine preliminary ligation of the axillary, superficial, or deep femoral veins before the dissection of sarcomata of the extremities.

If an exploratory exposure of the sarcoma has been done without removal of the neoplasm; if the diagnosis has been previously established by a formal incisional biopsy; if a recurrence develops after incomplete excision of the tumor; or if the sarcoma fungates through the wound and yet a successful radical dissection of the tumor is considered feasible by the surgeon, it is an urgent necessity that the entire scar of the previous incision be completely removed with the specimen. The skin incision should be a wide elliptical one extending widely around the original wound area and including also the tract of the incision down to the deeper focus of the neoplasm. The author has seen many patients who have had recurrent sarcomata excised through new incisions with the old scars remaining intact, only to have subsequent recurrences develop along their pathways.

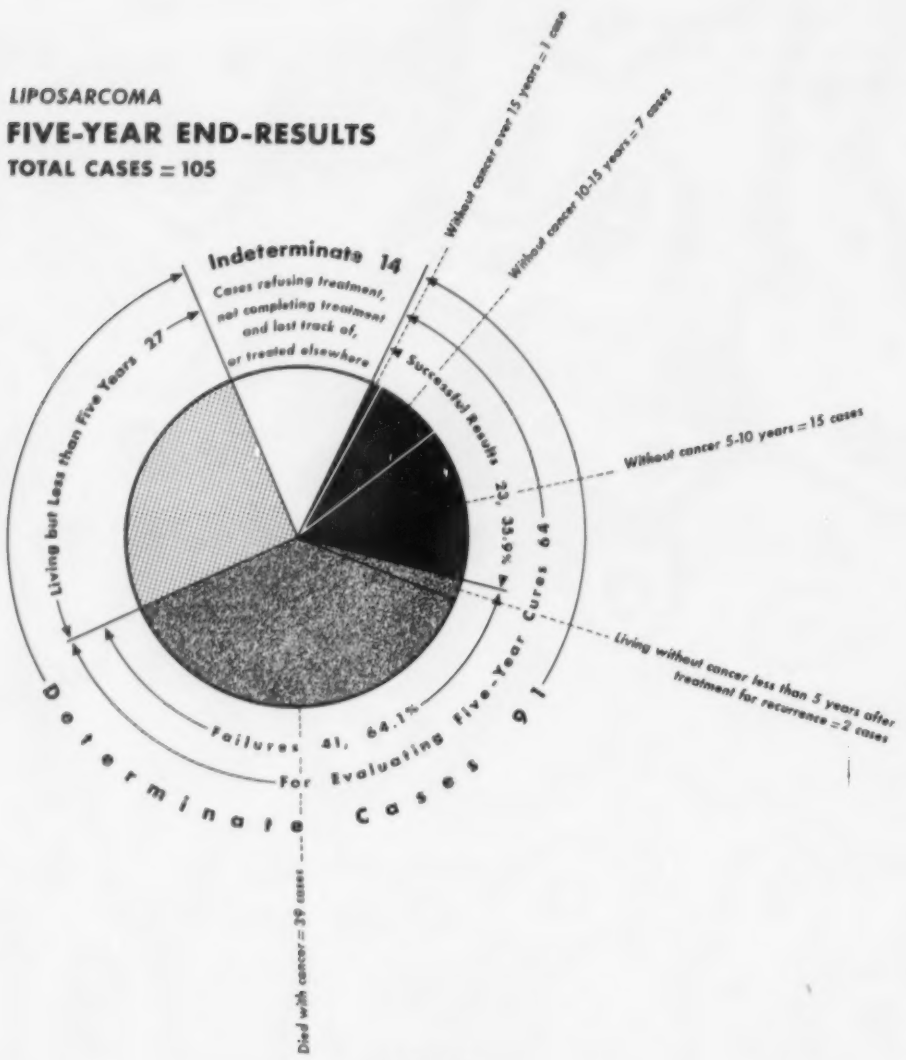
LIPOSARCOMA
FIVE-YEAR END-RESULTS
TOTAL CASES = 105
Indeterminate 14
Cases refusing treatment, not completing treatment and lost track of, or treated elsewhere
Without cancer over 15 years = 1 case
Without cancer 10-15 years = 7 cases
Without cancer 5-10 years = 15 cases
Living without cancer less than 5 years after treatment for recurrence = 2 cases
Successful Results 23, 35.9%
Five-Year Cures 64
Failures 41, 64.1%
For Evaluating Cases 91
Living but Less than Five Years 27
Indeterminate
Died with cancer = 39 cases

FIG. 13

The fact that the sarcoma is recurrent is sufficient indication to include the entire cleavage plane of the original incision within the surgical specimen. The disruption of the capsule or pseudocapsule of these sarcomata only too often permits a fungation of the rapidly growing tumor through the fresh incision.

The author attempts to remove the sarcoma without seeing or encountering it; this is accomplished by planning the lines of dissection well beyond the discernible boundaries of the neoplasm and by removing with it the enveloping muscles, fat, and fascia. Inasmuch as many sarcomata are pseudo-encapsulated and are easily enucleated, the temptation is great to shell out the tumor under the false assumption that its apparent localization ensures a cure by such a measure. Enucleation should never be employed, because local recurrence is almost inevitably the rule. It has been the writer's routine practice to excise the entire group of muscles which are either involved by or which surround the

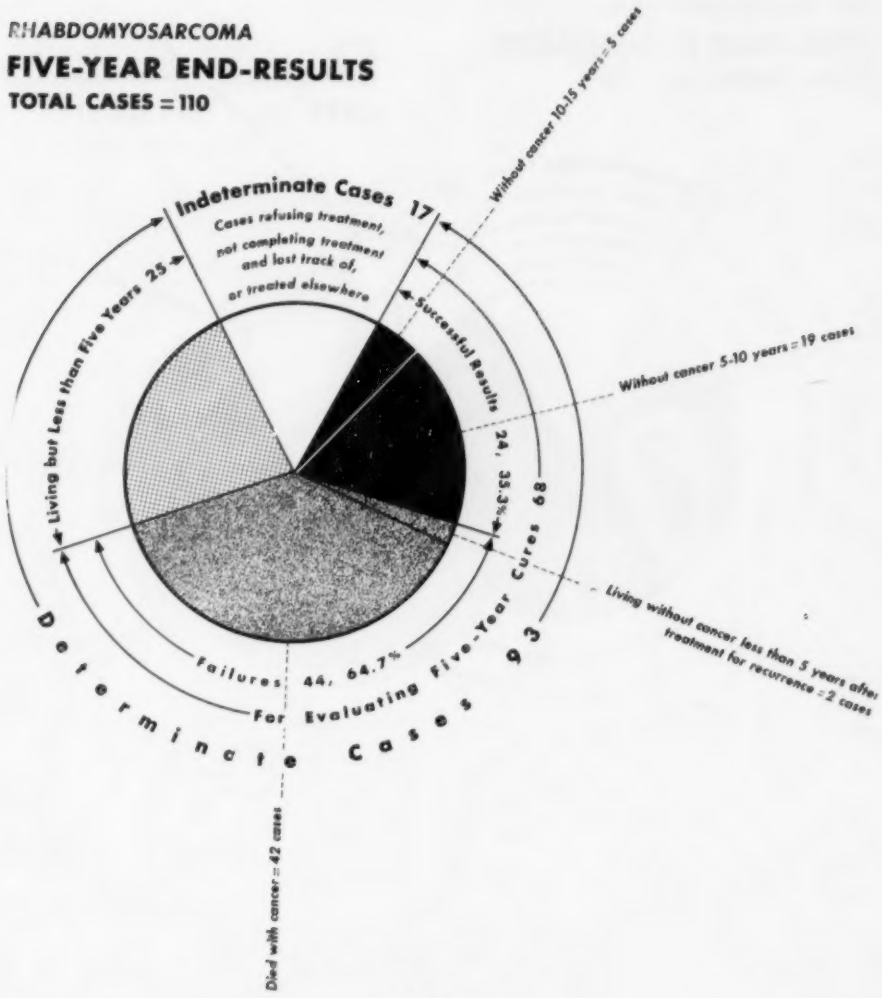
RHABDOMYOSARCOMA
FIVE-YEAR END-RESULTS
TOTAL CASES = 110
Indeterminate Cases 17
Cases refusing treatment, not completing treatment and lost track of, or treated elsewhere
Without cancer 10-15 years = 5 cases
Without cancer 5-10 years = 19 cases
Living without cancer less than 5 years after treatment for recurrence = 2 cases
Died with cancer = 42 cases
Living but Less than Five Years 25
Successful Results 24, 35.3%
Failures 44, 64.7%
Determinate Cases For Evaluating Five-Year Cures 68

FIG. 14

sarcoma; these muscles are removed from the origins to their insertions. This radical plan of attack is particularly indicated in the case of intermuscular liposarcomata and rhabdomyosarcomata. For sarcomata on the arms and legs, radical surgical dissection is done with the order of dissection from above downwards, that is, the radical dissection is started from the proximal aspect first. If the soft-part sarcoma involves muscle or fascia in immediate proximity to bone, the periosteum and occasionally cortical bone are chiseled away to ensure against the hazard of local recurrence. Bearing in mind the lethal possibilities of the sarcoma, the surgeon unhesitatingly removes adherent or implicated arteries and nerves, accepting the compromise of impaired function or disability *in lieu* of the other alternative, which is amputation.

The therapeutic problem of soft-part sarcomata of the chest wall is of critical importance, because an initial failure cannot be rectified by subsequent amputation, as in the case of sarcomata of the extremities. The initial surgical attempt should be of great radicality and, if the tumor is adherent to the ribs or extends intercostally, a ruthless resec-

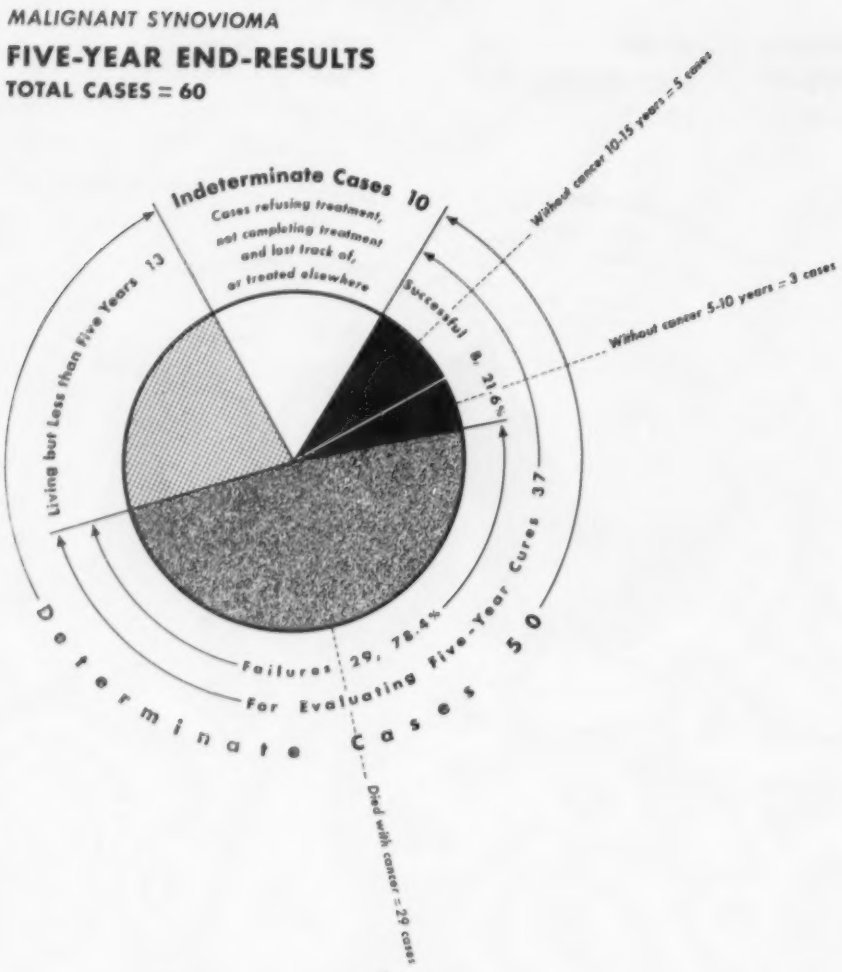
MALIGNANT SYNOVIOMA
FIVE-YEAR END-RESULTS
TOTAL CASES = 60
Indeterminate Cases 10
Cases refusing treatment, not completing treatment and lost track of, or treated elsewhere
Without cancer 10-15 years = 5 cases
Without cancer 5-10 years = 3 cases
Successful 8, 21.6%
Living but Less than Five Years 13
Failures 29, 78.4%
For Evaluating Five-Year Cures 37
Determinate Cases 50
Died with cancer = 29 cases

FIG. 15

tion of the thoracic bony cage should be done. Numerous thoracoplastic measures are available for repair, such as the transposition of muscle groups, sliding skin flaps, metallic-mesh inserts, and free fascial transplants.

Technical difficulties of the same order occur in the management of sarcomata of the abdominal wall. Large soft-part sarcomata of the abdominal parietes present most formidable surgical undertakings, inasmuch as a properly planned operative removal demands the sacrifice of large muscle groups, fascial planes, and, indeed, in some instances the entire thickness of the abdominal wall. Wound closure of such defects offers a difficult problem, which has been immeasurably aided by the more recent advent of metallic-mesh inserts. Tumors of the retroperitoneum which are usually lipomata, liposarcomata, ganglioneuromata, neurilemomata, and lymphomata are insidious in their growth and may achieve a large size before their presence is discovered. Our experience, totaling a group of 140 retroperitoneal tumors, has convinced us of the great technical difficulties involved in the total removal of these neoplasms. Massive intestinal resections, sacrifice of ureter and kidney, excision of the inferior vena cava, resection of the iliac artery, vascular grafts, and other operations of similar magnitude, are performed in conjunction

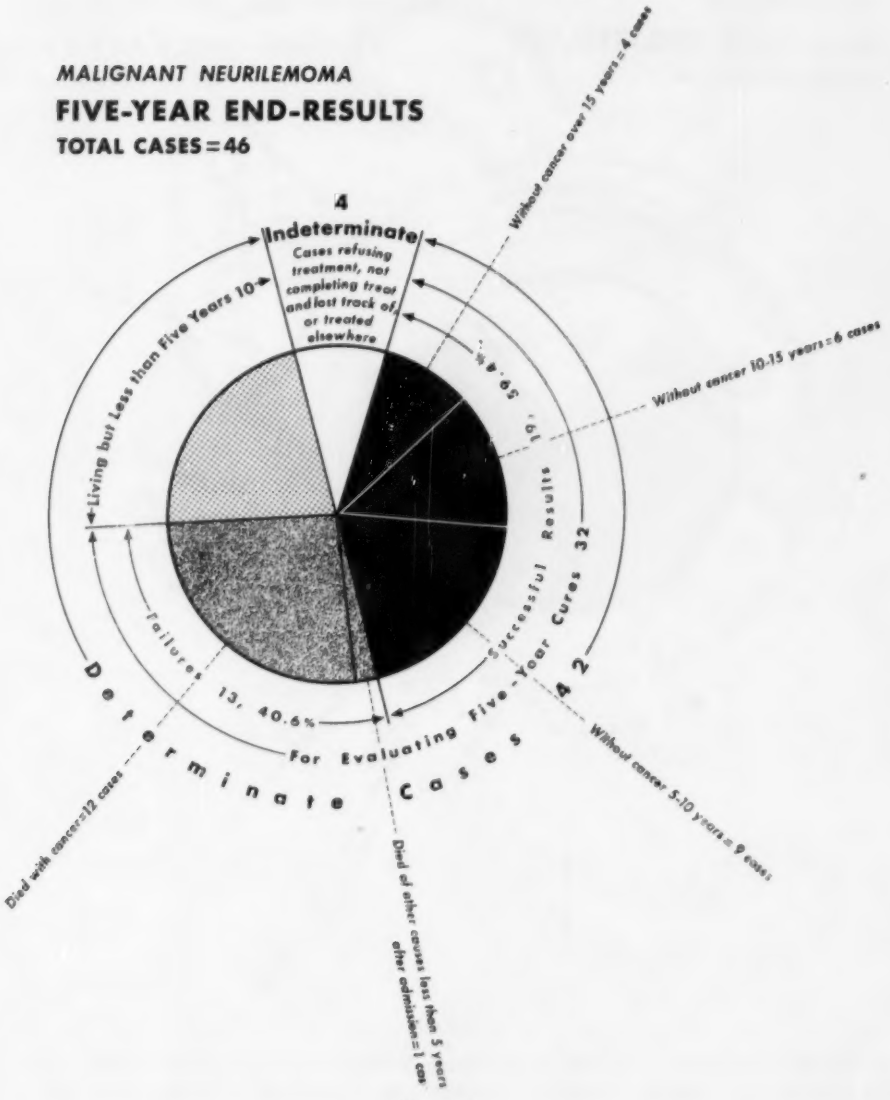
MALIGNANT NEURILEMOMA
FIVE-YEAR END-RESULTS
TOTAL CASES = 46
4
Indeterminate
Cases refusing treatment, not completing treat and lost track of, or treated elsewhere
Without cancer over 15 years = 4 cases
Without cancer 10-15 years = 6 cases
Without cancer 5-10 years = 9 cases
Died of other causes less than 5 years after admission = 1 case
Died with cancer = 12 cases
Living but Less than Five Years 10
Successful Results 19, 59.4%
Successful Five-Year Cures 32
Failures 13, 40.6%
For Evaluating Five-Year Cures
Determinate Cases
42

FIG. 16

with the removal of these neoplasms. Retroperitoneal tumors are notoriously prone to recur locally. Surgical removal of intrathoracic schwannomata, gangliomata, and lipomata from the posterior mediastinum is usually not a technically difficult procedure.

Radiation therapy is an aid in the management of sarcomata of the soft somatic tissues and must be given a proper place in the armamentarium of the therapist. In our experience, there have been many instances in which technically inoperable sarcomata have received preliminary irradiation, which has permitted resection and ultimate cure. With a combination of radiation treatment and surgical excision, it has been possible to perform radical surgical dissections of certain sarcomata and to avoid amputation of a limb. The judicious choice of surgery or irradiation or a combination of the two for the individual patient ensures a higher percentage of definitive cures. It entails some knowledge

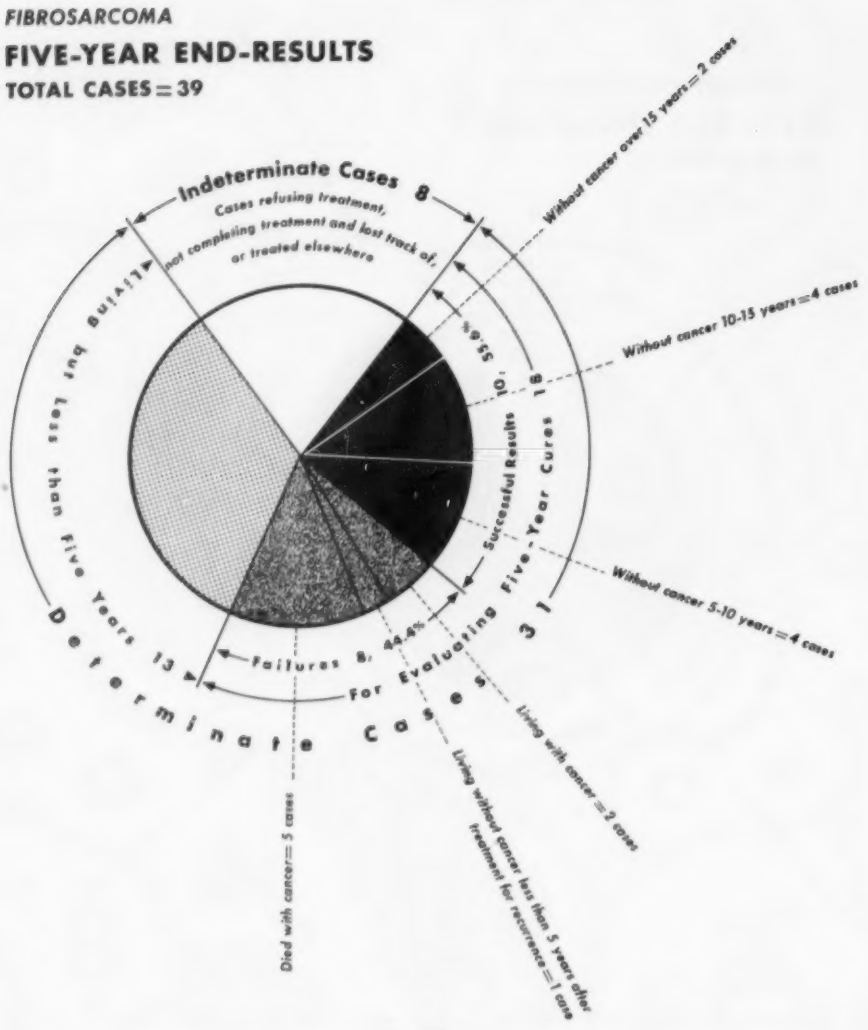
FIBROSARCOMA
FIVE-YEAR END-RESULTS
TOTAL CASES = 39
Indeterminate Cases 8
Cases refusing treatment, not completing treatment and lost track of, or treated elsewhere
Without cancer over 15 years = 2 cases
Without cancer 10-15 years = 4 cases
Without cancer 5-10 years = 4 cases
Living with cancer = 2 cases
Living without cancer less than 5 years after treatment for recurrence = 1 case
Died with cancer = 5 cases
Living but less than Five Years 13
Successful Results 10, 55.6%
Five-Year Cures 18
Failures 8, 44.4%
For Evaluating 31
Determinate Cases

FIG. 17

of the radiosensitivity of sarcomata of varying histogenesis and familiarity with the physical principles of irradiation, in order to employ these methods of therapy judiciously.

DO SARCOMATA OF THE SOFT SOMATIC TISSUES METASTASIZE TO REGIONAL LYMPH NODES?

A popular misconception concerning cancer behavior has been that malignant epithelial tumors metastasize by way of the lymphatic circulation, and that malignant mesenchymal tumors metastasize only through the blood vascular system. The influences which determine the routes of metastasis of malignant tumors are quite intangible but are modified, perhaps, by certain factors which include the histogenesis of the tumor, its invasive tendency, its vascularity, the distribution and character of its blood and lymph supply, and the specific site or organ involved by the malignant tumor. The author has long held the opinion that the configuration of the individual cancer cell partly determines the manner of dissemination. An example of this may be found in the ordinary epidermoid cancer of the skin; it usually metastasizes through the lymphatics. Under certain con-

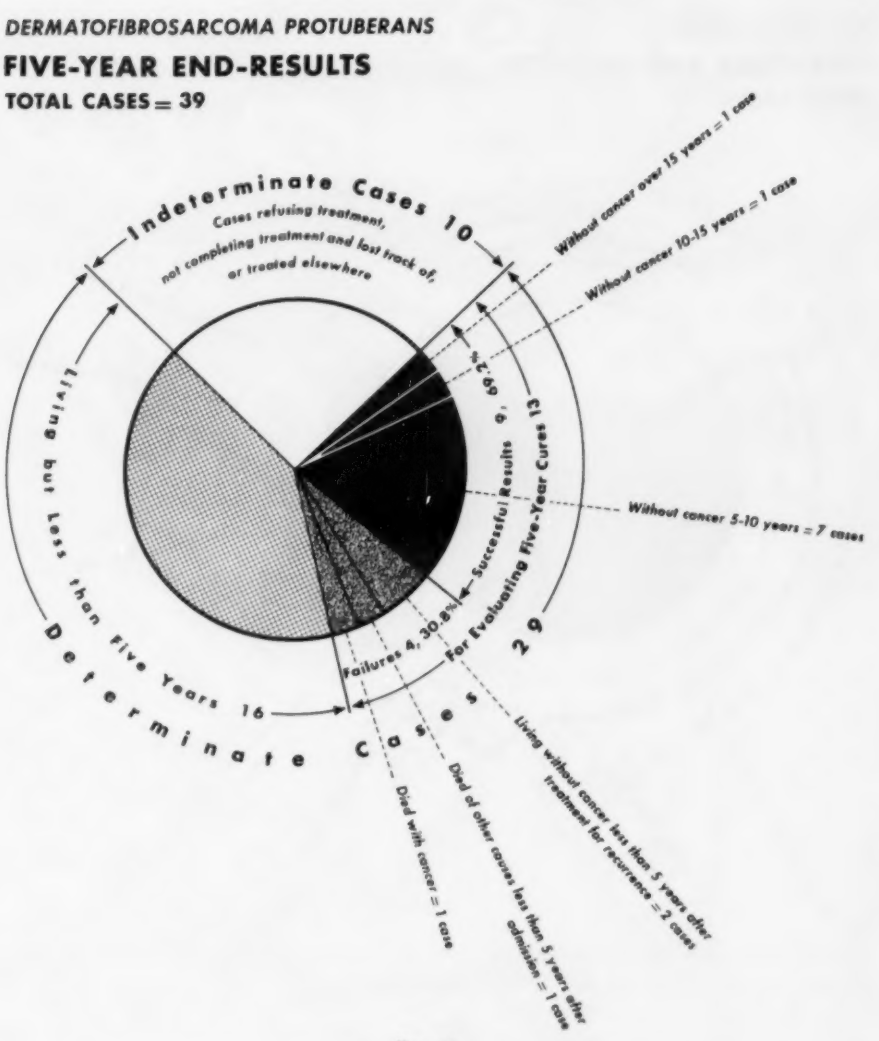
DERMATOFIBROSARCOMA PROTUBERANS
FIVE-YEAR END-RESULTS
TOTAL CASES = 39
Indeterminate Cases 10
Cases refusing treatment, not completing treatment and lost track of, or treated elsewhere
Without cancer over 15 years = 1 case
Without cancer 10-15 years = 1 case
Without cancer 5-10 years = 7 cases
Successful Results 9, 69.2%
For Evaluating Five-Year Cures 13
29
Failures 4, 30.8%
Determinate Cases
Living but less than Five Years 16
Living without cancer less than 5 years after treatment for recurrence = 2 cases
Died of other causes less than 5 years after admission = 1 case
Died with cancer = 1 case

FIG. 18

ditions, especially when such cancers develop in scar tissue or in chronic radiation dermatitis or in acrodermatitis chronica atrophicans, a peculiar spindle-cell metaplasia occurs and, in keeping with this cell form, we have seen metastases distributed diffusely to viscera by way of the blood vascular system.

Although the majority of soft-part sarcomata metastasize through the blood, a certain number of them will spread through lymphatics to regional lymph nodes. In times past, we occasionally discovered large masses in the groin or axilla in patients who had been successfully treated for sarcomata situated distally in the respective extremities; such masses were often considered to be tumor thrombi in veins and were indicative of fatal prognosis, and this was often the case. However, as more and more of these masses have been dissected, it has been found that the regional lymph nodes often did contain metastatic sarcoma. The rhabdomyosarcomata, malignant synoviomata, and angiosarcomata and spindle-cell sarcomata of undetermined histogenesis are apparently the varieties of soft-part sarcomata which are more prone to have lymphatic dissemination

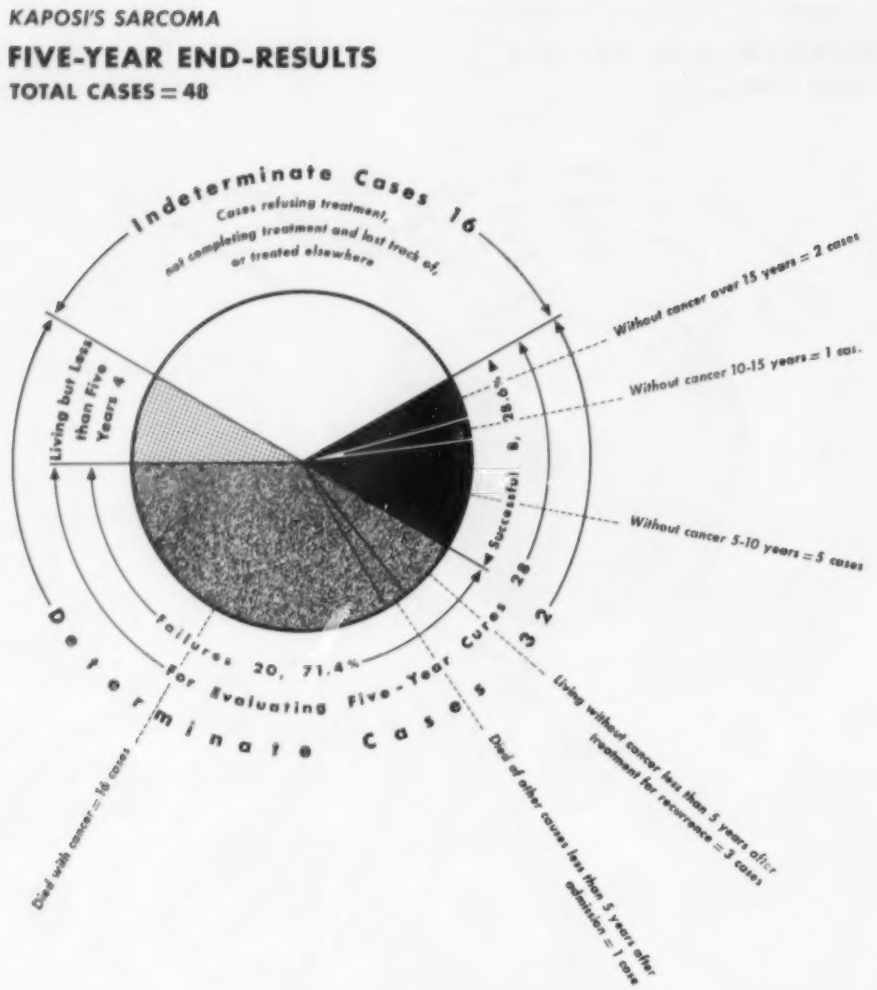
KAPOSI'S SARCOMA
FIVE-YEAR END-RESULTS
TOTAL CASES = 48
Indeterminate Cases 16
Cases refusing treatment, not completing treatment and lost track of, or treated elsewhere
Living but Less than Five Years 4
Without cancer over 15 years = 2 cases
Without cancer 10-15 years = 1 cas.
Without cancer 5-10 years = 5 cases
Successful 28
Living without cancer less than 5 years after treatment for recurrence = 3 cases
Died of other causes less than 5 years after admission = 1 case
Failures 20, 71.4%
Died with cancer = 16 cases
Determinate Cases 32
For Evaluating Five-Year Cures 28

FIG. 19

to regional lymph nodes. The knowledge that sarcomata may metastasize by the lymphatics to regional nodes is of considerable importance to the surgeon, as it should modify the scope of his plan for regional dissection of the primary sarcoma if the tumor is closely situated to the lymphatic drainage basin.

THE PRINCIPLE OF EXCISION AND DISSECTION IN CONTINUITY FOR PRIMARY AND METASTATIC SARCOMA

The dissemination of sarcomata of the soft somatic tissues to viscera via the blood vascular system renders the disease incurable, although palliative measures such as conservative surgical treatment and radiation therapy may be indicated. On the other hand, if the sarcoma of soft parts metastasizes through the lymphatic vessels to regional lymph nodes—as we have demonstrated does occur in the case of certain synoviomata, rhabdomyosarcomata, spindle-cell sarcomata of undetermined histogenesis, and the rare angio-endotheliomata—there is no occasion for complete despair concerning the ultimate prognosis. If the primary sarcoma is sufficiently close to the regional lymph nodes secon-

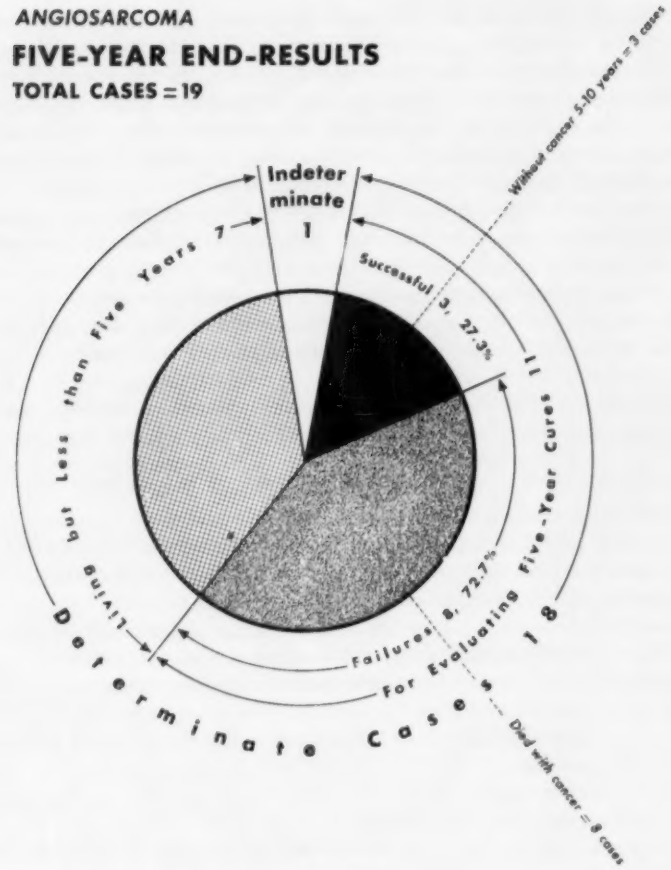

FIG. 20

darily involved, it is still possible to remove the primary tumor and the secondary deposits within the lymph nodes by a wide encompassing excision, the so-called monobloc operation. Depending on the location of the sarcoma, one may design an operation in the individual case which will accomplish this procedure of "excision and dissection in continuity",—that is, removal of both the primary and metastatic tumors *en masse* during the one operative session. This principle embodies the removal of the intervening lymphatics through which metastases occur; it is the same principle which has proved so successful for many years in radical mastectomy for cancer of the breast and malignant melanomata of the skin.

The somatic sarcomata of different histogenetic types exhibit such a wide regional distribution that the plan of an operation to remove them and the regional lymph nodes into which they may secondarily deposit themselves requires considerable ingenuity, in addition to a knowledge of the pathways of lymphatic drainage. Sarcomata of the soft somatic tissues are notorious for the frequency of their local recurrence. Hence it is extremely important for the initial operation to be a radical dissection of the magnitude described, unless the lesion is situated on the extremities and amputation becomes imperative.

As we conduct the operation of excision and dissection in continuity, a wide expanse of skin overlying the sarcoma is sacrificed, together with the intervening skin overlying

the lymph nodes. The skin flaps are dissected widely back, by the method similar to that employed in radical mastectomy, in order to remove the subcutaneous tissues, fat, and fascia from the overlying muscles. The muscles enveloping the tumor, if it be deeply situated, are removed in continuity with the surgical specimen, and a meticulous and radical dissection of the regional lymph nodes is accomplished. The wide lateral dissection of the skin flaps may permit primary approximation of the skin without the necessity of grafting. Skin-grafting should be done if the sarcoma is so large as to require wide removal of skin. The specimen so removed comprises the primary tumor, the suprajacent skin, the fascia and subcutaneous tissues through which the lymphatics course between the sarcoma and the regional lymph nodes, and the muscles enveloping the neoplasm, together with the lymphoid, fat, and areolar tissues in the conjoined drainage basin.

Although the principle is a good one, it cannot be employed when the metastases in lymph nodes are remotely distant from the site of the primary tumor, as in the case of a sarcoma of the hand or foot with metastases to axillary or inguinal lymph nodes, respectively. When this unfortunate combination of circumstances occurs, the surgeon is forced to perform an amputation superior to the level of lymphatic metastases.

PRINCIPLES OF AMPUTATION FOR SARCOMA OF THE EXTREMITIES

In previous publications concerned with the subject of major amputations—that is, interscapulothoracic amputation, hip-joint disarticulation, and interilio-abdominal amputation (hemipelvectomy)—the author has adumbrated the indications and contra-indications governing the choice of amputations for sarcomata of the soft somatic tissues. The surgeon, each time he is faced with a patient having a sarcoma on the extremities, must debate with himself concerning the value of preserving the extremity and the wisdom of amputating it. Only experience can dictate the decision in each case, although such factors as the location of the tumor, its histogenesis, the degree of malignancy, its primary or recurrent status, its encapsulation, or its infiltrative method of growth may modify the ultimate choice of procedure.

An example may be cited of successful conservative surgery in the case of synovial sarcomata involving the central segment of the hand. This segment with attached fingers has been amputated through the carpometacarpal articulation, allowing the preservation of the thumb and the fourth and fifth fingers, or the fifth finger only, to constitute a lobster-claw hand. The retention of the thumb permits apposition of thumb and fingers, which is most useful for grasping. Another instance of conservative amputation is for sarcomata—usually synoviomata—involving the lateral half of the foot. The resection of the lateral metatarsal bones with the corresponding toes and preservation of the great and second toes, together with the heel, maintains the longitudinal arch of the foot; such a foot does tire easily but is weight-bearing. *Per contra*, sarcomata which infiltrate the medial segment of the foot commonly require amputation of the entire foot, because the loss of the arch does not leave a useful extremity. Sarcomata involving the hands and feet are closely approximated to bone and nerves and have a tendency to infiltrate between the metacarpal and metatarsal bones, destroying them either by infiltration or by erosion. This manner of growth militates against the success of attempts at local surgical excision.

Cineplastic procedures utilizing muscle and tendon functions with the service of an artificial hand have followed forearm amputations for malignant soft-part tumors. The decision concerning the superior limits of severance is an important one, as it may mean the difference between cure and local recurrence. The law which we have constantly observed has been to amputate superior to the level of origin of the muscle groups involved by the sarcoma. Some of these laws may be summarized as follows:

1. Rhabdomyosarcomata are occasionally of multicentric origin; if the muscle groups in which the tumor occurs are not removed in their entirety, later recurrence may appear from the other foci, which may be impalpable at the time of the resection.

2. Sarcomata of the soft somatic tissues infiltrate along the fascial and muscular planes far superior to the palpable limits of the tumor.

3. Fascial fibrosarcomata are sometimes so diffuse in their manner of growth and so prone to recur locally that the entire fascial sheath should be removed, even if this necessitates removal of the periosteal base of attachment superiorly to bone.

4. When amputating an extremity for malignant neurilemoma, the surgeon experiences considerable anxiety concerning the safe level of amputation, because of two facts: namely, the tendency of these tumors to extend centripetally upward along the nerve sheaths and the co-existent beading of the nerve trunks by the neurofibromatous process characteristic of von Recklinghausen's disease.

5. Invasion of bone by these sarcomata permits subperiosteal and intramedullary extension of the tumor along the shaft, in consequence of which amputation either through or above the joint with which the diseased bone articulates is invariably performed.

Amputation of an extremity necessitated by non-neoplastic diseases or trauma requires the utmost attention so that as much of the limb as possible is conserved. In the case of malignant tumors it is of primary concern to amputate so high that the risk of local recurrence is avoided. For example, if the sarcoma of the soft somatic tissues is so located as to require the loss of the elbow and the distal portion of the arm, it is usually unwise to perform the conventional mid-humeral amputation. It is the author's opinion that there is no place in the roster of cancer operations for disarticulation of the humerus; in place of humeral disarticulation, he has favored interscapulothoracic amputation, contending that it is more radical, ultimately safer, and crippling in no greater degree. In support of this contention are the occasional metastases to axillary lymph nodes of certain sarcomata of the soft somatic tissues, the centripetal or upward extension of the fibrosarcomata, fascial sarcomata, and malignant neurilemomata along the fascial planes and nerve sheaths, together with the obvious fact that the shoulder without the arm offers no functional advantage to the patient other than the cosmetic value of its presence. In conclusion, therefore, the writer wishes to reiterate that humeral disarticulation should be deleted from the category of cancer operations and that interscapulothoracic amputation for all malignant tumors above the elbow is an infinitely better surgical procedure.

In the lower extremity, of course, conservation of the upper portion of the thigh is of greater functional importance because the preservation of even a small stump is of advantage in adaptation to an artificial limb. There are patients with hip-joint disarticulation or hemipelvectomy who wear cumbersome artificial limbs and have done so for many years; but the continued use of these prostheses is often a matter of pride rather than useful function.

PULMONARY LOBECTOMY AND SEGMENTAL EXCISION FOR METASTATIC SARCOMATA TO THE LUNG

The greater number of our patients who die of sarcomata of the soft somatic tissues owe their fatality to pulmonary metastases rather than to local recurrence or continued extension of the original tumor. A common natural history of these sarcomata is that local radical surgical treatment is successful, but visceral metastases, notably to the lungs, become apparent some three, four, or five years later. Some patients at the time of death or on postmortem study show no evidence of residual or recurrent sarcoma. The pulmonary metastases are usually well demarcated spherical bodies in the parenchyma and, inasmuch as the mode of dissemination is usually by embolic showers through the blood vascular system, one might reasonably expect numerous rather than single metastatic foci. For every tumor embolus which becomes successfully transplanted to and grows in the lung, there may be hundreds which die. Routine observational x-rays of the chest may reveal one or more asymptomatic nodules in a single pulmonary lobe.

Before the feasibility of operating for the removal of these metastases is considered, it is a proper plan to study the lungs by anteroposterior and lateral laminagraphy. By this means other cryptic metastatic foci may become visible, which might not be visualized in the conventional chest roentgenograms. The discovery of such widespread multiple metastases will influence the surgeon against futile palliative pulmonary resections.

If the pulmonary metastasis appears to be a single focus or if two or three metastases are confined within a lobule, the surgeon may properly attempt a lobectomy or a segmental resection. In this series it has been found to have definite palliative value. Of course, it is not considered feasible if the metastatic sarcoma is obviously infiltrative with fixation of the hilus. Perhaps the duration of palliative relief for these patients is sometimes longer than that obtained by surgical removal of some primary bronchogenic cancers.

END RESULTS IN THE TREATMENT OF SARCOMATA OF THE SOFT SOMATIC TISSUES

To present the end results of treatment, certain graphic forms have been chosen in order to show clearly what can be accomplished for each histogenetic type. The indeterminate group of cases include those patients who refused the treatment advised, who did not complete the treatment, or who were treated elsewhere. Of the determinate cases, those treated within the past five years cannot be used for analysis of cure rates. The balance of cases treated more than five years ago constitute the material on which the definitive five-year cure rates are based.

The large group listed under the classification of sarcomata of undetermined histogenesis requires a word of explanation. However competent the pathologist and however careful the selective staining, tissue culture, and study of gross anatomical characteristics of these neoplasms, there remains a residue which defies classification as regards histogenesis. Into this "catch-all" category fall those sarcomata which we futilely label as sarcomata of undetermined histogenesis. The writer looks askance at any reported series in which every sarcoma has been identified as to its cell of origin. One might properly question the comparative curability of these different sarcomata, because of the likelihood that the sarcomata of undetermined histogenesis contain the most anaplastic or undifferentiated and, therefore, the most malignant tumors, which might by subtraction give a false higher rate of curability for the identifiable types, such as the synoviomata, liposarcomata, rhabdomyosarcomata, and others. In refutation of such an assumption, the five-year rate of definitive cure is 41.3 per cent. for the sarcomata of undetermined histogenesis, as compared with a cure rate of 39.2 per cent. for the entire collective series of soft-part sarcomata.

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MYXOMA OF BONE

BY WILLIAM H. BAUER, M.D., AND ALEX HARELL, M.D., ST. LOUIS, MISSOURI

From the Department of Pathology, Schools of Medicine and Dentistry, and the Department of Orthopaedic Surgery, School of Medicine, St. Louis University

Tumors of the long bones of primitive mesenchymal origin are not common. Their cytological pattern resembles that of Wharton's jelly with or without a sprinkling of fibrous tissue. Neoplasms of this type are called myxomata and myxofibromata. Stout postulated that a true myxoma must be "composed of stellate cells set in a loose mucoid stroma through which course very delicate reticulin fibers in various directions". He allowed "some degree of fibrosis", but stipulated that "these areas should not be extensive".

This report is concerned with the microscopic findings in an expanding bone tumor which on the basis of clinical findings was suspected of being malignant, but which proved to be a benign myxoma.

CASE REPORT

J. N. (No. 5225907), a twelve-year-old white male, complained of slight pain along the left thigh and in the left knee of about two to three months' duration. Physical findings were not significant. There was full knee motion, but tenderness was noted on resisted motion. The roentgenogram showed a sharply outlined area of bone destruction, four by six centimeters on the medial aspect of the distal metaphyseal end of the femur (Fig. 1). The lesion had expanded the cortical contour and was internally bordered by a thin sclerosed layer of bone. A limited area of the expanded cortex showed erosion, which led several roentgenologists to consider the lesion as "very probably malignant". Laboratory findings were within normal limits.

A biopsy was performed on July 24, 1952. At operation on August 1, 1952, the periosteum appeared vascular and adherent to the fascia and bone. The cortical layer was thin, soft, and easily compressible. Through a window cut into the cortex, a glistening, snowy mass became visible which filled the entire medullary area. Since examination of the tissue removed revealed the benign nature of the tumor, the area involved was resected and the defect was filled with autogenous iliac bone. Serial roentgenograms, the last made eight

FIG. 1

The roentgenograms showed a large ovoid, eccentric lesion in the distal metaphysis of the femur. The expanded growth was internally bordered by sclerosed bone.

FIG. 2

Roentgenograms made eight months after the removal of the myxoma showed the progress of healing.

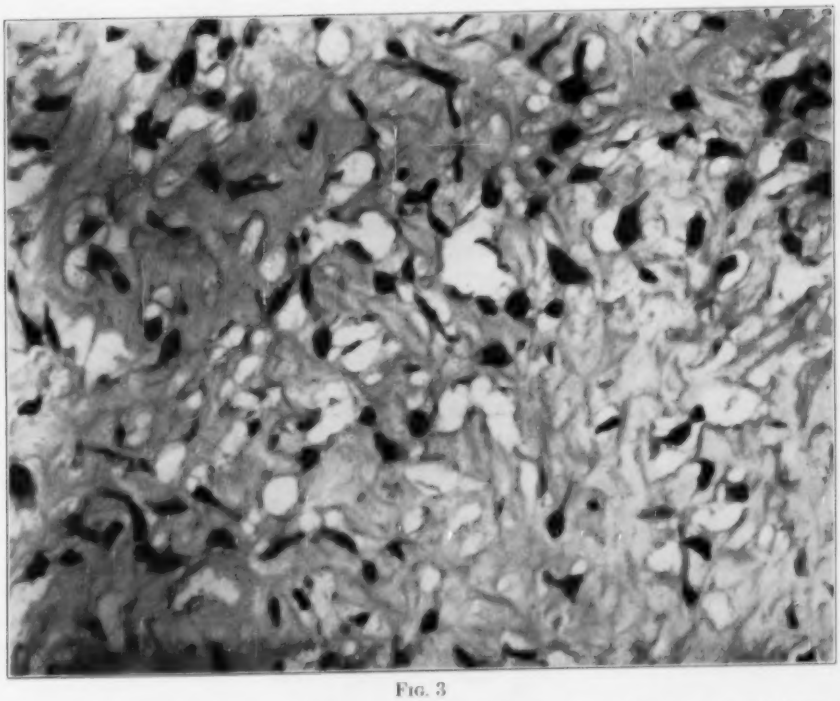

FIG. 3

Photomicrograph (× 300) showing stellate cells with fibrillar extensions in a myxoid intercellular matrix.

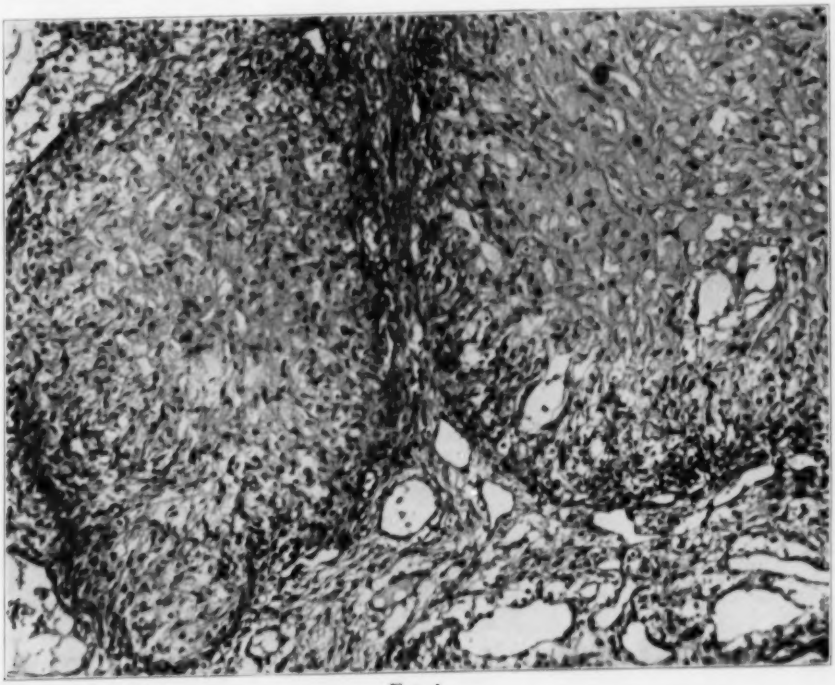

FIG. 4

Photomicrograph (× 105) showing thin strands of vascular fibrous tissue between lobules of myxomatous tissue.

months after operation, showed that healing was progressing well (Fig. 2). Chest roentgenograms showed no abnormal changes.

Microscopic Findings

The sections of the specimen removed were stained with hematoxylin and eosin and with Mayer's hematein (alcoholic solution). Masson's trichrome technique and Wilder's silver-impregnation method for reticulum fibers were also employed.

The lobulated neoplasm was composed of stellate cells in a vascular mucoid stroma with delicate fibrils (Fig. 3). The latter were argyrophil, as demonstrated by the Wilder silver-impregnation technique. The nuclei of the stellate cells of various shapes and sizes were large and vesicular or small and hyperchromatic. The cells were scattered in a vacuolated material which gave a positive Mayer's hematein stain for connective-tissue mucin. This stain showed a negative reaction toward the periphery of the lobules where the myxomatous material blended with collagenous fibrous tissue, which coursed between the lobules and occasionally extended into the myxomatous areas (Fig. 4). Loose connective tissue and extravasation of blood were also noted between the accumulations of stellate cells in a mucoid matrix. The adjacent bone was sclerotic and a few newly formed bone trabeculae projected into the tumor.

DISCUSSION AND SUMMARY

The microscopic findings reported fulfill Stout's criteria for "myxoma". Stout observed ten myxomata of bone and collected sixteen cases from the literature. Most of them occurred in the jaws, mainly in the mandible, and the rest in the long and flat bones, metatarsals, and phalanges. As to age distribution, Stout's table showed that the tumor may develop at any age.

The mucoid material in the tumor described is of connective-tissue origin, as the stain proved. Even a negative reaction, however, would not necessarily militate against this explanation, since the mucoid substance may be "hyaluronic acid and not mucus" [4]. Primitive mesenchyme contains a large amount of hyaluronic acid. As regards the argyrophil fibrils in the mucoid stroma, the authors agree with Sponsel, McDonald, and Ghormley that these elements should be called "silver-staining fibrils", in order to avoid the controversy over whether they are precollagenous fibers or reticulin fibers. The amount of fibrosis was not such as to warrant the diagnosis of a myxofibroma. No cartilaginous or bony elements were found. However, the small collagenous and fibrous areas indicated a slight tendency toward higher differentiation. This trend supports our opinion that occasionally a myxoma may locally show chondroid and fibrous tissue and so became a chondromyxoid fibroma. The latter has been described by Jaffe and Lichtenstein as a more mature tumor, and Lichtenstein pointed out that it "is sometimes misinterpreted as a myxoma of bone". One of the authors (Bauer) observed such a transition in three bone tumors of primitive mesenchymal origin, one in the proximal metaphyseal area of the fibula of an eleven-year-old girl, one in the rib of a forty-year-old male, and one in the rib of a female sixty-two years old. Neoplasms of primitive mesenchymal tissue may locally differentiate into cartilage and bone.

As to the nature of the myxoma of bone reported here, the healing process and the present excellent health of the boy confirm Stout's statement that the myxoma is a benign neoplasm.

Stout's opinion that there are no histopathological criteria to distinguish between myxoma and myxosarcoma was not shared by Sponsel and his associates, who stressed the greater vascularity, perivascular accumulation of cells, and variety of silver-staining fibrils in myxosarcoma of the soft tissue.

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SOLITARY UNICAMERAL BONE CYST *

BY GEORGE J. GARCEAU, M.D., AND CHARLES F. GREGORY, M.D., INDIANAPOLIS, INDIANA

From the Department of Orthopaedic Surgery of Indiana University School of Medicine and St. Vincent's Hospital, Indianapolis

Until the publication of the classic paper by Bloodgood in 1910, little distinction was made among various cystic conditions occurring in bone. That study delineated the group of lesions referred to subsequently as the fibrocystic diseases and further studies led to the classification of the unicameral bone cyst as a distinct entity.

The material for this report was obtained from a clinical study of twenty-seven cases by the authors and a review of the literature. Cases from the literature were not accepted unless there was ample evidence that the lesion was actually a true unicameral bone cyst.

While the known cases of this lesion have occurred between the ages of one and fifty years, it is most frequently observed in the first two decades of life. The greatest incidence is between the ages of nine and fourteen years. It occurs in males approximately twice as often as in females.

The long bones are almost invariably involved, but the calcaneus is also involved frequently. About 75 per cent. of solitary bone cysts occur in the humerus or in the femur. In the femur and in the humerus the cyst is most likely to be found in the proximal end of the bone.

FIG. 1

A: The cyst is lying against the epiphyseal plate and is therefore in the "active" phase.

B: There is an interval of normal bone between the cyst and the epiphyseal plate and the cyst is therefore classified as being in the "latent" phase.

The proximal and distal ends of the tibia show a relatively equal distribution of involvement. The mid-shaft is seldom involved in any bone. In the calcaneus, which is the single exception to the infrequent occurrence outside of the long bones, the cyst generally develops in the anterolateral and superior portion.

In the light of distribution of the lesions within given bones and of the age groups in which they are predominantly found, it is interesting to speculate regarding correlation

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FIG. 2

Roentgenograms from different patients illustrating different types of bone tumors. *A*: Solitary unicameral cyst with a fracture. *B* and *B*$_1$: Fibrous dysplasia. *C* and *C*$_1$: Non-osteogenic fibroma. *D*: Giant-cell tumor.

TABLE I

DISTRIBUTION OF CYSTS IN THE SKELETON

	Authors' Series (27 Cases)		Cases in Literature (313 Cases)	
	No.	Per cent.	No.	Per cent.
Femur	11	40.8	110	35.1
Humerus	10	37.0	121	38.6
Tibia	2	7.4	41	13.0
Radius	0	0.0	5	1.5
Ulna	1	3.7	5	1.5
Fibula	0	0.0	8	2.5
Calcaneus	2	7.4	9	2.8
Others	1	3.7	14	4.4

between the occurrence of the lesion and factors having to do with both growth and remodeling processes. For it is apparently during the periods of growth and at locations within bones where high rates of growth or refined and extensive bone remodeling occur that the cyst seems to be most frequently encountered. Since the basic pathological process is one of bone resorption, it is most likely to be associated with remodeling which has got out of control. Beyond this speculation as to etiology, no theory of cyst origin has ever been effectively sustained. Theories have ranged from that of Pommer, who postulated the occurrence of an intramedullary hematoma due to some mild or forgotten trauma and a failure of its resorption, through explanation on the basis of metabolic disorders or localized acute bone atrophy, to the concept maintained by Phemister that bone cysts are probably a mild form of osteomyelitis and are, therefore, basically similar to Brodie's abscess of bone. All of these theories have had to yield to exception entirely too often to be sustained.

The uncomplicated bone cyst usually presents a dearth of clinical signs and symptoms. Unless a fracture has taken place, a dull, often intermittent and usually mild pain or ache in the area involved is the only complaint. The roentgenographic examination will reveal the first sign of the cyst.

Roentgenograms will reveal the following features:

1. Evident destruction of medullary bone;
2. Destruction of bone on the inner side of the cortex;
3. Subperiosteal new-bone formation causing the appearance of expansion;
4. An expansile defect in the metaphysis;
5. Trabeculated lines in the wall of the cyst causing the appearance of multiloculation. These scroll-like elevations on the inner wall of the cyst are easily seen at the time of surgery.
6. A thin dense cyst wall may separate the cyst from the medullary cavity of the bone; this is an indication that the lesion is old.

Serial roentgenograms will show the cyst being pushed away from the epiphysis and will reveal any change in the size of the cyst.

Since the solitary cyst is most frequently encountered in the metaphyseal portion of a long bone, it bears a rather significant relationship to the epiphyseal plate. This relationship has been classified not alone for academic reasons but also because of its clinical importance. The cyst frequently is found to abut directly against the epiphyseal plate but very rarely projects across it. Jaffe and Lichtenstein have considered this relationship to imply a state of activity and have designated the cyst so situated as one in the "active" phase. The counterpart of this state is the so-called "latent" phase, said to be present when an interval of normal bone is found lying between the epiphyseal plate and the cyst. The active phase of the cyst is construed to be that state in which the cyst is actively en-

FIG. 3-A FIG. 3-B

W. K., three years old. Fracture through the cyst was treated by traction and bed rest.

FIG. 3-C FIG. 3-D

Figs. 3-C to 3-H: Showing healing of fracture and progress toward obliteration of the cyst.

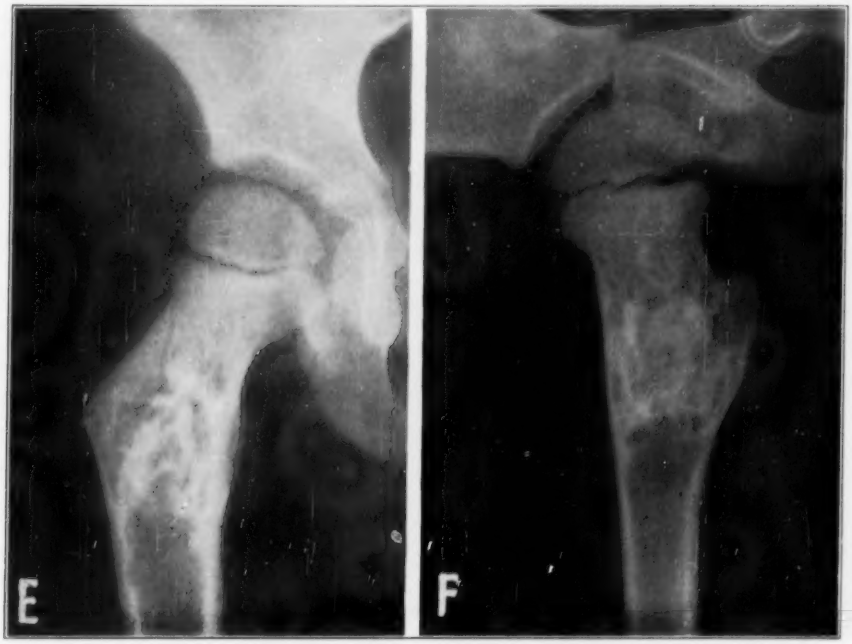

FIG. 3-E FIG. 3-F

FIG. 3-G FIG. 3-H

larging, while in the latent phase the cyst remains quiescent and the epiphyseal plate migrates away from it.

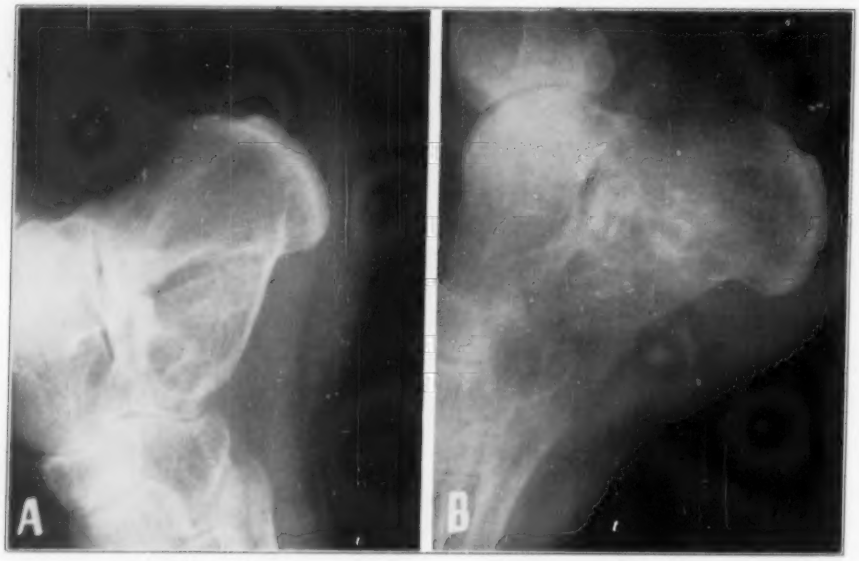

FIG. 4-A

FIG. 4-B

FIG. 4-C

Fig. 4-A: L. M., white female. Roentgenogram made May 20, 1947, shows cyst as originally noted.

Fig. 4-B: May 22, 1947. Roentgenogram made after curettage and implantation of bone chips.

Fig. 4-C: May 15, 1952. Roentgenogram made five years after operation.

PATHOLOGY

The gross pathological features noted at surgery are as follows:

1. There is an area of fusiform expansion in the bone.

2. The periosteum lifts away easily and the underlying bone is usually thin and presents a bluish cast. Entry is easily accomplished through the attenuated cortex.

3. The cavity is incompletely occupied by a variable amount of yellowish fluid. It may be red or hemorrhagic if there has been recent trauma.

4. A variable amount of connective tissue will be found lining the wall; this amount ranges from a distinct membrane one or two millimeters in thickness to only a small quantity of connective tissue obtained by careful scraping.

5. Scroll-like ridges or elevations on the inner side of the cyst wall may be noted.

6. A thin layer of bone separates the cyst from the medullary canal of the normal portion of the diaphysis, which is part of the cyst wall and of about the same thickness.

MICROSCOPIC PATHOLOGY

The microsections offer little more information, usually showing only the aforementioned tissue lining as well as a few spicules of new and old bone. In many of these

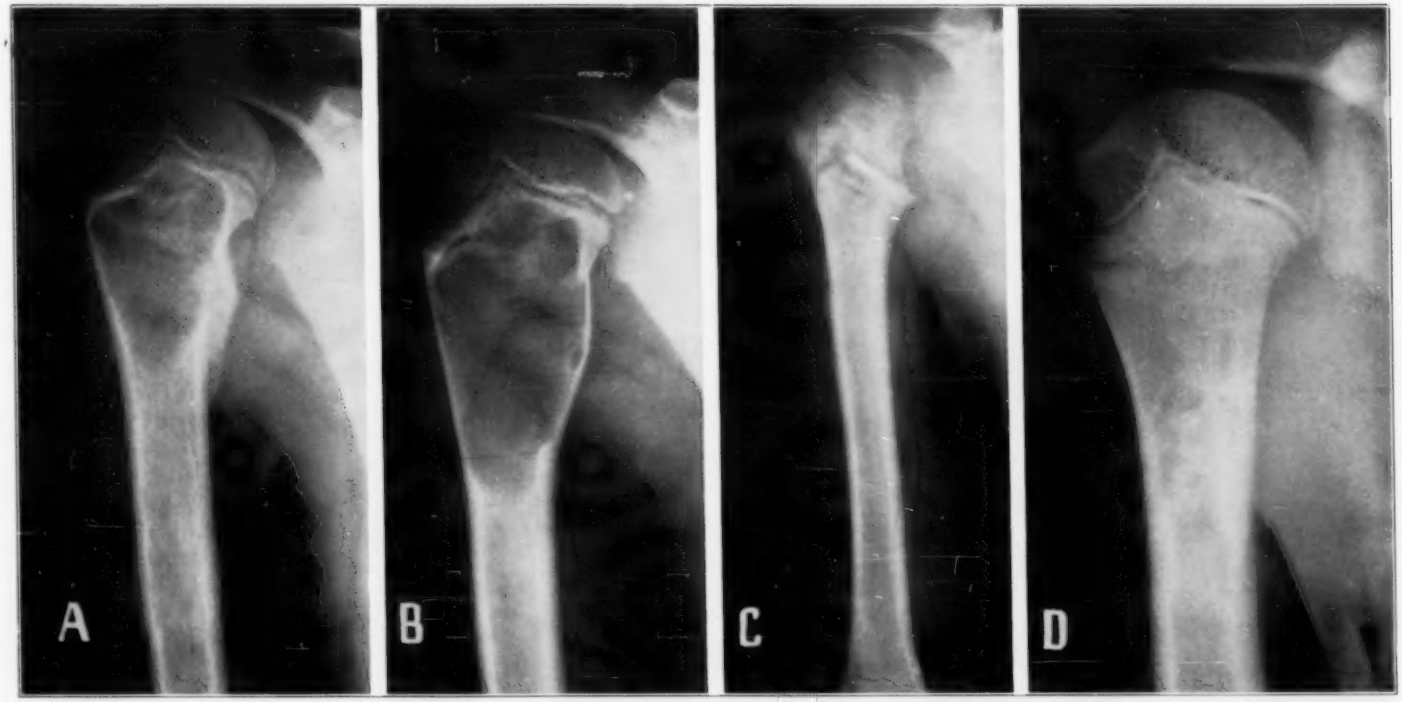

FIG. 5-A FIG. 5-B FIG. 5-C FIG. 5-D

Fig. 5-A: K. B., white male, aged nine. Roentgenogram made December 20, 1946, showed an active cyst and a fracture through the cyst.
Fig. 5-B: Roentgenogram made April 24, 1947. The fracture had united, but the cyst had enlarged.
Fig. 5-C: October 27, 1947. Roentgenogram made after curettage, collapse, and implantation of bone chips.
Fig. 5-D: March 2, 1950. Roentgenogram made three years after surgery.

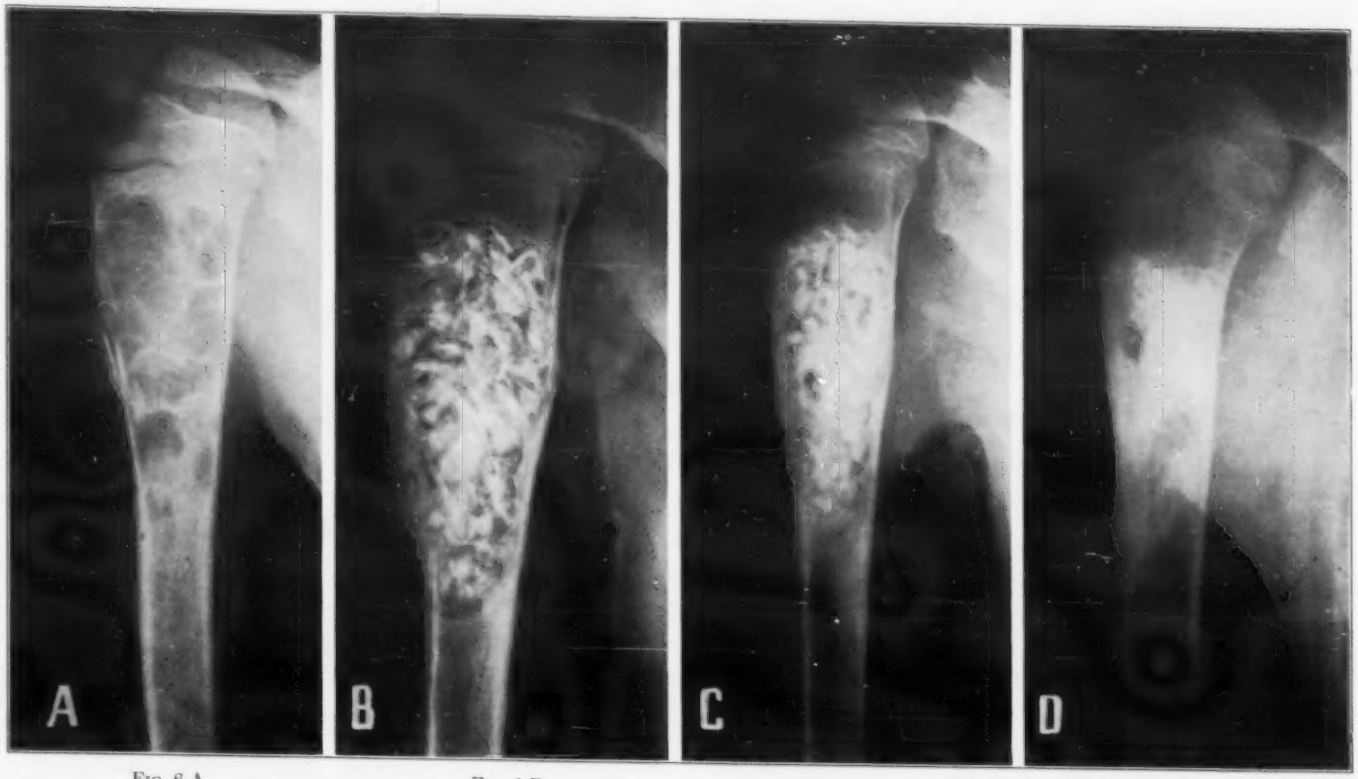

FIG. 6-A FIG. 6-B FIG. 6-C FIG. 6-D

Fig. 6-A: D. H., white male, aged twelve. Roentgenogram made October 14, 1949, showed a latent cyst with a fracture.
Fig. 6-B: Roentgenogram made December 10, 1949, one month after operation.
Fig. 6-C: February 4, 1950.
Fig. 6-D: Roentgenogram made May 6, 1950, seven months after curettage and implantation of a graft from the bone bank.

TABLE II

INCIDENCE OF FRACTURE IN SOLITARY BONE CYST

	Authors' Series (27 Cases)		Cases in Literature (87 Cases)		Total	
	No.	Per cent.	No.	Per cent.	No.	Per cent.
Single fractures	17	62.9	47	54.0	64	56.1
Multiple fractures	2	7.4	8	9.2	10	8.8
Total	19	70.3	55	63.2	114	64.9

spicules, osteoblastic activity may be noted on the one surface and osteoclastic activity on the other. If metaplasia of fibrous tissue to fibrillar new bone is encountered, the diagnosis of solitary cyst must be carefully questioned.

The laboratory findings relative to calcium and phosphorous metabolism and the levels of the alkaline and acid phosphatase have all been found to be within normal limits.

DIFFERENTIAL DIAGNOSIS

Although the diagnosis is usually not difficult, some of the lesions which should be considered in the differential diagnosis are listed as follows:

1. Fibrous dysplasia;
2. Non-osteogenic fibroma;
3. Giant-cell tumor;
4. Enchondroma;
5. Osteitis fibrosa cystica resulting from hyperparathyroidism;
6. Neurofibroma;
7. Lipoma.

Some of the difficulties which may be encountered in diagnosis were evident in Kleinberg's case. He reviewed the case of a white male, twenty-five years old, who had had a cyst in the proximal end of the femur since the age of two; a correct diagnosis was not made until the patient was four years old. Roentgenographic studies over a period of twenty years were available. The cyst originally extended to within one-half inch of the epiphyseal plate, but later occupied the base of the neck and the trochanteric area. When the patient was twenty-five years old, the cyst was exposed surgically. The portion of the cyst in the base of the neck was thin-walled and lined with connective tissue. The part within the trochanteric area had a thick wall and no lining membrane. Obliteration of the cyst occurred following curettage and filling with autogenous chip grafts.

This may be described as the classic and uncomplicated history of a solitary bone cyst. One may speculate whether or not the cyst remained active for a period of twenty years. The thick walls of the trochanteric portion may indicate an attempt at healing.

TABLE III

FRACTURE WITH HEALING OF THE CYST

	No.	Per cent.
Authors' series (27 cases)		
Cases with fracture	19	70.4
Cases with cyst healing	3	15.7
Cases in literature (87 cases)		
Cases with fracture	55	63.2
Cases with cyst healing	8	14.5
Combined percentage for both series		14.8

The presence of a lining membrane in the upper part of the cyst could indicate activity, although we cannot be certain that a detectable lining membrane suggests activity.

COMPLICATIONS

Fracture, the most common complication, often brings the lesion to medical attention. Table II tabulates the incidence of fracture in our series and in eighty-seven cases from the literature in which fifty-five patients had suffered fractures. It may be noted that the incidence in our series was 70 per cent., while it was 63 per cent. for the series obtained from the literature, for a combined incidence of 65 per cent. in 114 cases of bone cyst.

As many as four fractures through the same cyst have been reported. We are aware of only one instance of non-union reported in the literature. This was reported by Milgram in his discussion of Kleinberg's paper. Non-union was not encountered in our series.

The question whether a cyst is ever obliterated in the course of healing of a fracture is a point which has received a great deal of consideration. If the cyst is in the active stage, it may actually enlarge and be associated with another fracture later. We have carefully surveyed our cases and those in the literature for a record of cyst obliteration with fracture healing; our findings are recorded in Table III.

While the generalization that obliteration of the cyst usually does not follow fractures is true, certainly an incidence of 15 per cent. of obliteration of the cyst after no treatment other than that applied for the fractures is worthy of mention. This is not meant to imply

FIG. 7-A FIG. 7-B FIG. 7-C

Fig. 7-A: R. B., white male, aged four. Roentgenogram made February 16, 1949, showed appearance of cyst after treatment by curettage.

Fig. 7-B: August 25, 1949. The roentgenogram revealed evident recurrence.

Fig. 7-C: Roentgenogram made October 22, 1949, showing result of the third operation of curettage and collapse.

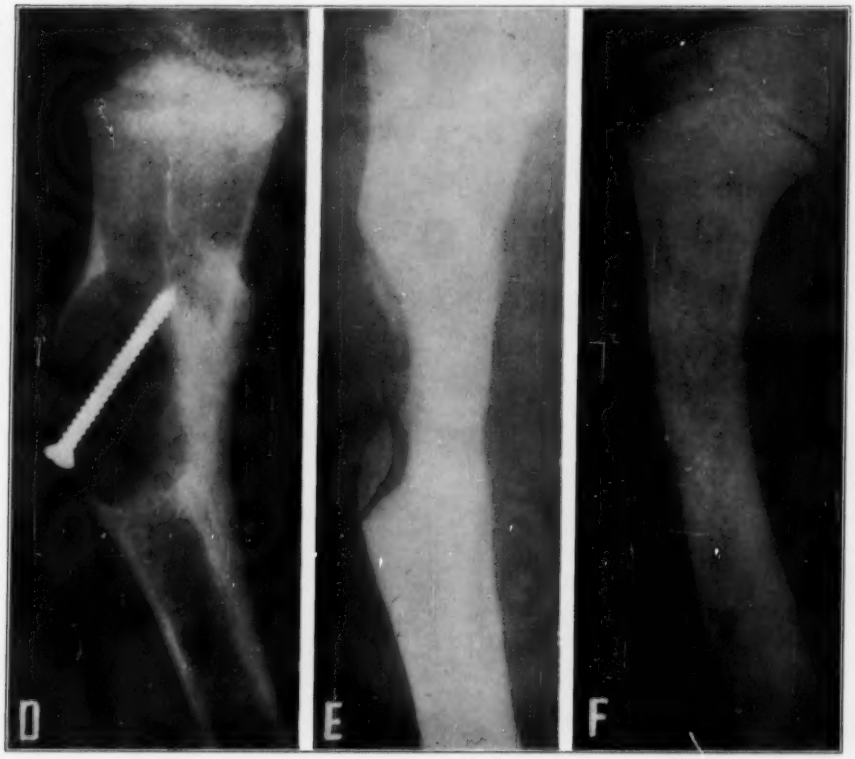

FIG. 7-D FIG. 7-E FIG. 7-F

Fig. 7-D: Roentgenogram made March 18, 1950.

Fig. 7-E (May 15, 1950) and Fig. 7-F (May 15, 1951): Showing results of a fourth procedure of local resection.

that we advocate conservative treatment for a solitary bone cyst followed by a fracture, but the treatment of the fracture is an emergency procedure while that of the cyst is an elective one.

TREATMENT

Essentially three basic forms of treatment have been employed, roentgen therapy, transplantations of autogenous or homogenous bone grafts, and total resection of the cyst area. From this list of possibilities a number of combinations can be selected. Cauterization of the cyst wall is an adjunct which has frequently been employed with the various surgical techniques. Table IV lists the various combinations used in the two series.

Of the twenty-six failures, eight patients were between one and four years old, twelve were between five and nine years, three were between ten and fourteen years, one was between fifteen and nineteen years, and the remaining two were over nineteen years old.

The technique of curettage combined with some form of bone-grafting has given the most consistently satisfactory results. Roentgen therapy usually fails to effect obliteration of the cyst. We have found three cases reported in the literature [1,3] in which secondary malignant changes subsequently occurred in lesions so treated. One of the most significant observations of our study is that twenty of the twenty-six cases of failure occurred before the age of ten years.

As was observed earlier, the concept of the active as opposed to the latent phase of the cyst introduced by Jaffe and Lichtenstein is of more than academic importance; this

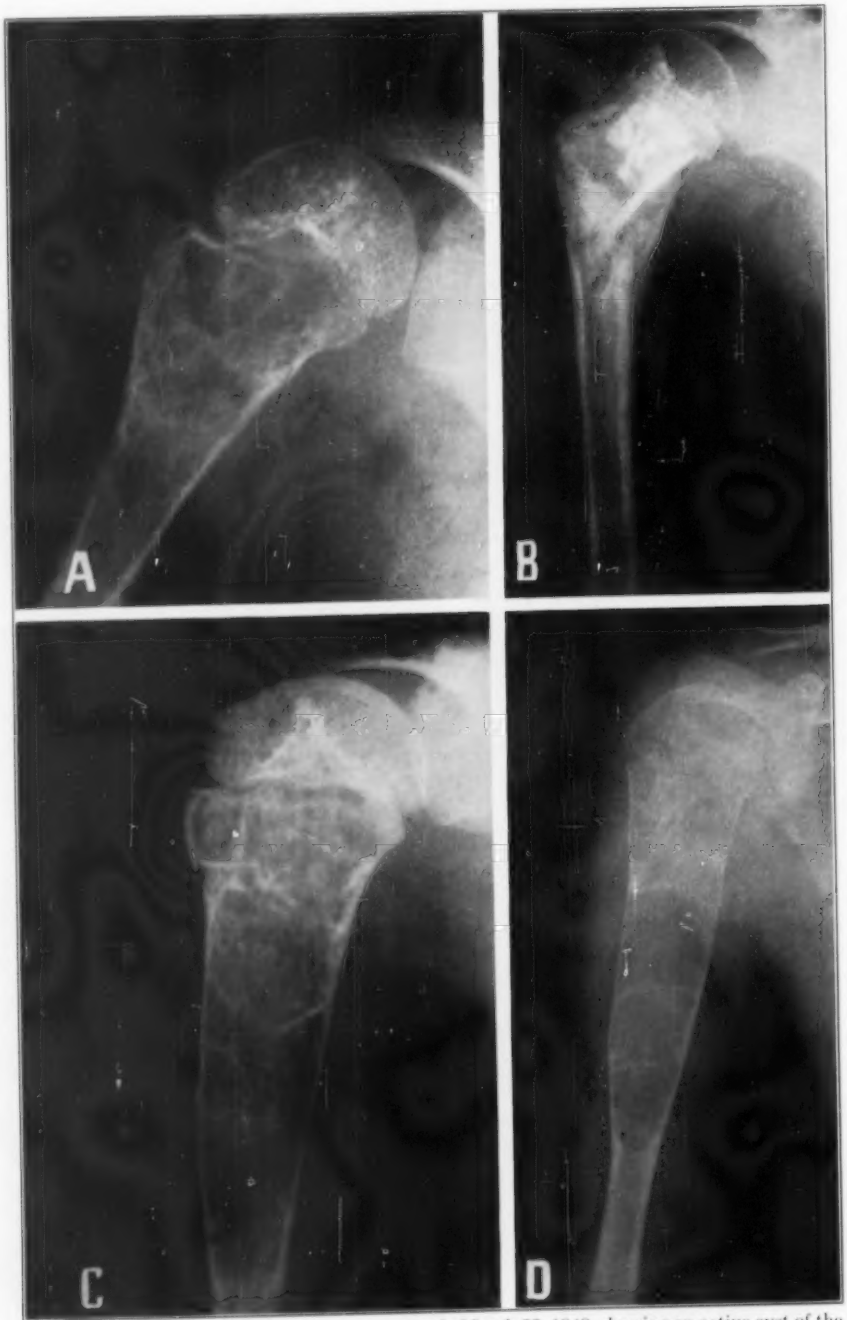

Fig. 8-A: K. G., white girl. Roentgenogram made March 22, 1948, showing an active cyst of the left humerus.

Fig. 8-B: Roentgenogram made May 12, 1948, after curettage, collapse, and implantation of bone chips.

Fig. 8-C: Roentgenogram made November 12, 1949, one and one-half years after operation.

Fig. 8-D: Roentgenogram made May 7, 1952, four years after operation. A second operation, on November 11, 1952, confirmed the recurrence of the cyst. (Note: Figs. 8-A through 8-D were accidentally reversed to show a right humerus. They should have shown a left humerus.)

TABLE IV

PRIMARY RESULTS OF TREATMENT

Method	Authors' Series		Cases in Literature	
	No.	Failures	No.	Failures
X-ray treatment only	2	2	2	1
Curettage only	3	1	17	2
Curettage and cautery			20	6
Curettage and chip grafts	6	0	29	6
Curettage and cortical grafts	4	1	14	2
Curettage, collapse, and chips	1	1		
Curettage, collapse, and massive grafts			1	0
Curettage, cautery, and chip grafts	2	1	2	0
Curettage and collapse	2	0	7	3
Curettage and total resection	1	0		
Curettage and x-ray treatment			1	0

was shown by Stewart and Hamel who made use of this concept in classifying the outcome of treatment. It was evident from their series that the cyst in the active stage was very liable to recur after treatment, while the cyst in the latent phase could usually be expected to respond quite satisfactorily to an acceptable surgical procedure. Except for Stewart and Hamel's series, we have encountered no report which has encompassed a similar end-result study. The study of our own series and of those cases from the literature in which the activity or latency of the cyst could be ascertained is recorded in Table V. In general the contention of these authors is borne out.

TABLE V

RECURRENCE RATE FOLLOWING TREATMENT IN THE ACTIVE OR IN THE LATENT PHASE

	Authors' Series		Cases in Literature	
	Healing	Recurrence	Healing	Recurrence
Active	5	2	10	7
Latent	8	3	17	0

However, because there were some exceptions in our series, and because we have found some technical difficulty in accurately determining the presence or absence of an interval of normal bone between the cyst and the epiphyseal plate, we have carried out a second study in which the results of treatment are compared with the age at the time of treatment. The results of that study are recorded in Table VI. This demonstrates that the incidence of recurrence in the cysts treated before the age of ten years is considerably higher than in those treated after the age of ten years. This observation is independent of the type of treatment applied. We believe this observation has practical implications which are inescapable.

TABLE VI

RECURRENCE RATE OF CYSTS TREATED BEFORE AND AFTER THE AGE OF TEN YEARS
(SIXTY-EIGHT CASES)

Treatment	Authors' Cases		Cases in Literature	
	Healing	Recurrence	Healing	Recurrence
Under 10 years	4	6	31	14
After 10 years	10	1	23	2

TABLE VII
RESULTS

	Authors' Series	Cases in Literature
Results of Primary Treatment		
Number of cases	19	91
Number of cysts healed	14	72
Number of recurrences	5	19
Results of Secondary Operations		
Number of operations	3	10
Number of recurrences	2	4
Results of Third Operation		
Number of cases	2	2
Number of recurrences	1	0

RESULTS

Table VII records the results of primary treatment in both series studied and reveals that the incidence of recurrence of the lesions is between 21 per cent. and 26 per cent. These are over-all results independent of the type of treatment, the state of the cyst, or the age of the patient at the time of surgery. In one of our cases the cyst healed with shortening of the humerus after the fourth operation, a resection of the cyst.

Although the objective of elective treatment is always the obliteration of the cyst and reconstruction of the bone to normal, this aim is realized in relatively few cases. Certainly if a cyst is nearly obliterated in a bone which is strong and shows no evidence of shortening, deformity, or interference with function, this can be considered an acceptable result.

The following classifications were used by the authors in the evaluation of end results:

Excellent: Complete obliteration of the cyst with reconstruction to normal bone;

Good: Minimal residual medullary scarring with intact cortices and good bone strength;

Fair: Multiple small cyst-like residua, possible scars, some residual expansion and deformity, but good over-all bone strength;

Poor: Frank recurrence of the cyst with thinned cortices and evident weakening of the bone.

We have chosen as our chief criterion the roentgenographic appearance of the lesion. Secondary consideration was given to deformity, shortening, and altered function in terms of their significance to the limb involved. If any of these clinical residua appear to any degree, the basic grade as determined by roentgenogram is lowered one point. However, we believe that final evaluation of any case should not be made until after puberty.

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SUBPERIOSTEAL GIANT-CELL TUMOR

Ossifying Subperiosteal Hematoma—Aneurysmal Bone Cyst *

BY PAUL C. THOMPSON, M.D. †, CHATTANOOGA, TENNESSEE

A threefold title has been used to bring together the ideas regarding a single entity which has been described in the literature under many apparently unrelated terms. This benign bone lesion characteristically occurs as a mass displacing or lying in soft tissues, with its base attached to the shaft of a long bone. The mass is surrounded by a thin, dome-like shell of calcified bone enclosing cystic spaces which are filled with blood. The lining of

TABLE I

Cases Reported in the Literature

Author	No. of Cases	Age	Sex	Location	Trauma	Duration (*Weeks*)
Van Arsdale	1	22	Male	Humerus	Yes	10
Cone	1	19	Female	Humerus	Yes	10
Geschickter and Copeland	4	17	Male	Femur	"Trauma had usually occurred"	6
		21	Female	Ulna		8
		58	Female	Humerus		2
		16	Female	Humerus		8
Coley and Miller	4	22	Male	Tibia	Yes	28
		12	Male	Femur	Yes	5
		30	Male	Femur	No	20
		16	Male	Tibia	No	24
Potts	1	6	Male	Mandible	Yes	6
Mayer and Kestler	1	23	Female	Vertebra (seventh thoracic)	No	20
Present	1	33	Male	Radius	Yes	8
Hodgen and Frantz	1	15	Female	Tibia	No	16
Lichtenstein	8	Not recorded	7 Male 1 Female	Vertebrae (third lumbar, first thoracic and seventh cervical, second cervical); femur (2); ulna; rib; and clavicle	Not recorded	Not recorded
Jaffe	"About" 20	Not recorded	Not recorded	Not all recorded	Not recorded	Not recorded

the cystic spaces is a very cellular tissue which may closely resemble a giant-cell tumor. Lesions involving vertebrae, flat bones, and small bones of the hands and feet may be modified from this classical pattern by local anatomy which permits or prevents the typical development.

Most of the articles in the American literature refer to the lesion as a hematoma which is ossifying or calcifying. Van Arsdale, in 1893, first reported such a case and regarded the tumor as an ossifying hematoma of subperiosteal origin resulting from definite trauma to the mid-shaft of the humerus. Bloodgood, in 1910, recognized the condition and interpreted it as a bone cyst due to periosteal hematoma with formation of a bony shell about the

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† Orthopaedic Fellow, Duke University, Georgia Warm Springs Foundation Training Program, National Foundation for Infantile Paralysis, Duke Hospital, Durham, North Carolina.

FIG. 1

A cauliflower-like mass arising from the neck of the talus in a nineteen-year-old white male. The cortex has not been invaded.

FIG. 2

Roentgenogram showing a tumor of the tarsal navicular in a fifteen-year-old white male.

hematoma. Cone, in 1928, was first to describe the detailed histological features of the tumor, and attached considerable importance to the blood-filled cystic center of the growth. He regarded the lesion as an ossifying subperiosteal hematoma resulting from trauma with various histological elements proliferating in the course of normal attempt at repair.

During the 1930's and 1940's, attention was focused on the microscopic aspects of the lesion and hence arose such terms as "subperiosteal giant-cell tumor" and "atypical giant-cell tumor", the former being introduced by Geschickter and Copeland in 1931 and the latter by Coley and Miller. These authors were also of the opinion that the growth developed following trauma and was histologically indistinguishable from true giant-cell tumor.

Such terms as "angioma" and "benign bone aneurysm", advocated by Ewing, were also suggested because of the vascular component of the growth. In 1950 Lichtenstein recommended the term "aneurysmal bone cyst" to avoid the misunderstanding which a term suggesting a neoplastic process may produce.

During the fifty-year period reviewed terminology was determined by the location of the lesion, the blood which filled the cystic center of the tumor, or the giant-cell stroma which predominated. In spite of this shifting terminology, all of the authors who have discussed the dynamics of the disease assign the primary role to local circulatory disturbances, and almost all authors believe that such disturbances are the result of trauma and the repair patterns provoked in response to injury.

Lichtenstein, while rejecting the explanation of traumatic origin, agrees with the concept of vascular disturbance. He believes that the lesion originates within bone and that the bony shell represents the "attenuated remnants of the original cortex". All other authors regard the lesion as originating about the periosteum and the shell as part of the repair process.

FIG. 3

FIG. 4

Fig. 3: Roentgenogram showing a typical lesion involving the diaphysis of a humerus with considerable cortical destruction in a thirteen-year-old colored female.

Fig. 4: Showing a large multiloculated mass with a broad base along the lesser trochanter in a white male, twenty-eight years old.

CLINICAL AND PATHOLOGICAL FEATURES

Additional information has been obtained from cases which the author had the privilege of observing at Duke University, Department of Orthopaedics, The North Carolina Orthopedic Hospital, and the Armed Forces Institute of Pathology.

Of interest is the general age distribution which is often below that of true giant-cell tumors. In the nine patients observed the age ranged from ten to twenty-eight years, four of the lesions being detected in patients under sixteen years of age. There appears to be a definite sex predominance, with males representing seventeen of the twenty-four patients in the literature and eight of the nine patients in this series.

Symptoms of soreness, dull aching pain, swelling, and limitation of motion occur, and in vertebral involvement signs of spinal-cord or nerve-root pressure may be present. The time interval from onset of symptoms to biopsy or surgical excision varied from two weeks to one year. In approximately 70 per cent. of the cases, roentgenograms demonstrated a tumor mass in patients with symptoms of less than three months' duration.

Trauma is assigned a clear and specific role in 71 per cent. of the cases in the literature, but the lesion not infrequently may develop without a definite history of injury, as was true in seven of the nine lesions observed by the author. Of particular importance as regards trauma is the case of a nineteen-year-old white male, in which roentgenograms made thirty-one days after injury revealed no abnormalities. Because of persistent symptoms, x-rays were made three months later (Fig. 1), and these showed a typical lesion. In such a case, at least, the trauma cannot be said to have merely drawn attention to the lesion. Another tarsal lesion (Fig. 2) was observed in a thirteen-year-old white male without a definite history of injury.

FIG. 5-A

FIG. 5-B

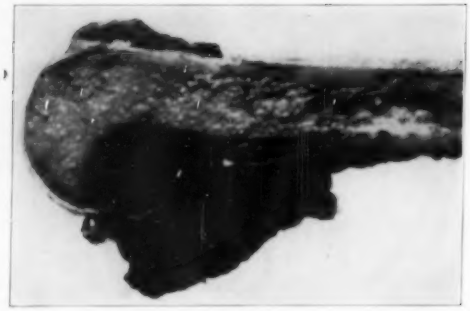

FIG. 5-C

Figs. 5-A and 5-B: Roentgenograms showing an osteolytic lesion in the posterior metaphyseal area of the humerus with the characteristic soft-tissue shell in a white male, twenty-five years old.

Fig. 5-C: The amputated specimen showed considerable bone destruction. Note also the cystic nature of the lesion. Amputation in this patient had been performed because of marked bone destruction and because microscopic studies revealed features simulating those of malignant giant-cell tumor.

The roentgenographic appearance varies during the natural growth of the tumor; in its early development the lesion produces a soft-tissue mass of increased density but without calcification or changes in the adjacent bone. The intermediate stage, during the third and fourth months, shows the gradual development of a domelike calcified shell outlining the periphery of the tumor. As time progresses, spontaneous healing may occur, with the mass becoming ossified.

The tumor is usually found along the diaphysis of any of the long bones, the femur and the humerus being the most common sites. In such a location the distinguishing roentgenographic feature of the tumor is its extension into the adjacent soft tissues. This portion of the tumor is attached by a broad base to the outer cortex and appears as a radiolucent cystic mass (Fig. 3). The growth is delineated peripherally by a thin, domelike, irregular bony shell filled with fine, honeycombed strands of ossified material. Not infrequently a segment of the underlying cortex may be destroyed for a distance of several centimeters, so that the medullary canal is exposed, but there is no expansion of the shaft. However, in several instances there was little if any evidence of cortical destruction (Fig. 4) and, as the growth matures, the mass may become ossified. The metaphysis may also be involved (Figs. 5-A and 5-B), as was seen in the x-rays of a white male, twenty-five years old, whose arm was amputated (Fig. 5-C) because of rather marked bone destruction and because microscopic examination revealed characteristics simulating those of malignant giant-cell tumor. In the long bones the tumor presents its most characteristic roentgenographic appearance and shows little similarity to the genuine giant-cell tumor.

In the flat bones and vertebrae the roentgenographic appearance is not so distinct, but

FIG. 6

Roentgenogram showing an expanding osteolytic multiloculated lesion of the right ischium in a fifteen-year-old colored male.

FIG. 7-A

FIG. 7-B

Anteroposterior and lateral roentgenograms showing a destructive process in the fourth lumbar vertebra. The ossifying mass is evident in the lateral view.

the same features—erosion of the underlying bone and extra-osseous location of the tumor mass—prevail. Instances of the tumor occurring in the pubis, ischium, clavicle, and ribs have been recognized; roentgenograms (Fig. 6) of a fifteen-year-old colored male in this series demonstrate a lesion in the ischium. The subperiosteal giant-cell tumor may occur in any region of the spine with involvement of the body, the neural arch, or both, of one or more vertebrae (Figs. 7-A and 7-B).

The first instance of this tumor in the spine was recorded by Mayer and Kestler in 1944 and was designated as "aneurysmal bone cyst". Lewis in 1924 commented on the

FIG. 8

Photomicrograph (× 10) made from gross specimen of amputated humerus, showing the characteristic pattern of large, blood-filled lakes and surrounding reactive bone. (Courtesy of Armed Forces Institute of Pathology, Washington, D. C.)

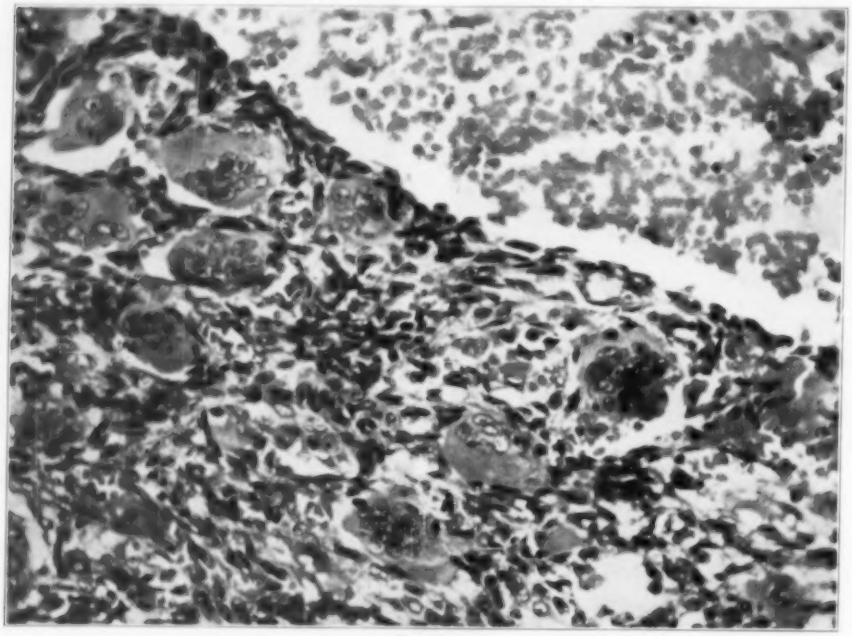

FIG. 9

Photomicrograph (× 120) showing spindle, polyhedral, and giant cells lining the sinus wall of the blood lake. (Courtesy of Armed Forces Institute of Pathology, Washington, D. C.)

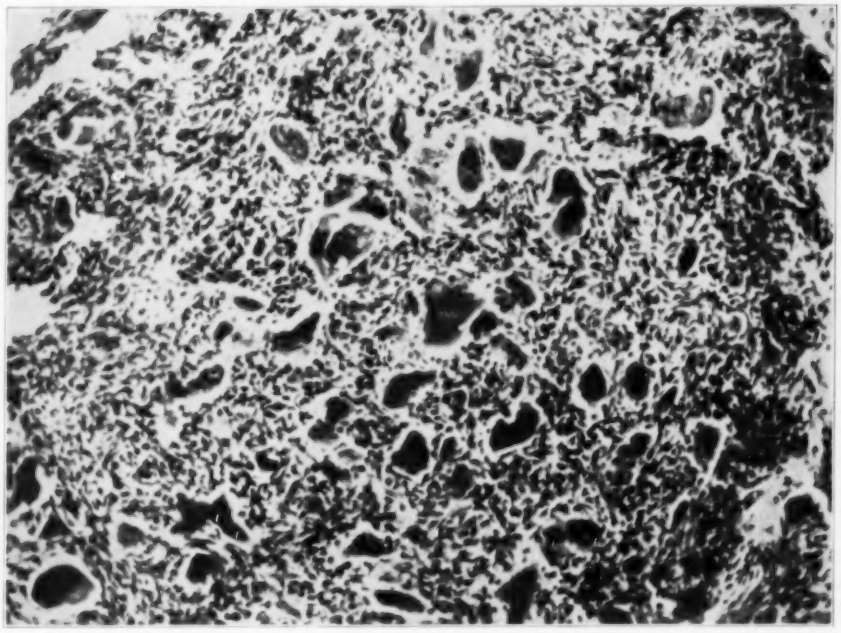

FIG. 10

Fig. 10 (× 142.5), Fig. 11-A (× 38), and Fig. 11-B (× 120): The giant-cell stroma pattern is seen adjacent to the blood lake, the opposite sinus wall being formed by osteoid tissue and trabeculae of woven bone. (Courtesy of Armed Forces Institute of Pathology, Washington, D. C.)

peculiar behavior and microscopic appearance of giant-cell tumors occurring in vertebrae. He recognized the occurrence of spontaneous regression and the frequency of ossification occurring in these lesions, and expressed doubt as to the neoplastic nature of many of the so-called giant-cell tumors of vertebrae. Thirteen of the seventeen lesions which he reviewed were cured by only partial removal or biopsy. He concluded that the lesion "resembled a giant-cell tumor", but suggested that "it represents some chronic resorptive process with an excessive formation of granulation tissue, which is not a tumor in the strict sense of the word". Bogart and Imler, as well as Brock and Bogart, have shown that roentgen therapy produces re-ossification and healing of such vertebral lesions. The occurrence of true neoplastic giant-cell tumors in vertebrae is open to question and cases so designated need review in the light of the papers by Lewis, Mayer and Kestler, and Lichtenstein.

On surgical exposure of the involved area, examination reveals the tumor mass to be encapsulated by a thin, ill-defined bony shell which is easily penetrated. One then encounters a reddish-brown, liver-like, friable mass interspersed with gritty matter, presumably spicules of bone. The center of the lesion, usually lying adjacent to the cortex (and occasionally extending into the medullary canal) is filled with a semiliquid substance having the appearance of a partially organized blood clot. Numerous surgical reports confirm the description of a highly vascular tumor which bleeds profusely but slowly on attempted surgical removal. In none of the cases in the literature or those observed by the author was mention made of pulsation either before or after removal of the peripheral shell. Cross section of three gross specimens showed the bony shell to be lined by firm, fibrous-like tissue peppered with spicules of bone, while the small semiliquid center was filled with what appeared to be a partially organizing blood clot.

Microscopic examination of the cystic center of the lesion reveals a marked hemangioma-like mesh of very large vascular sinuses filled with blood (Fig. 8). These sinuses vary

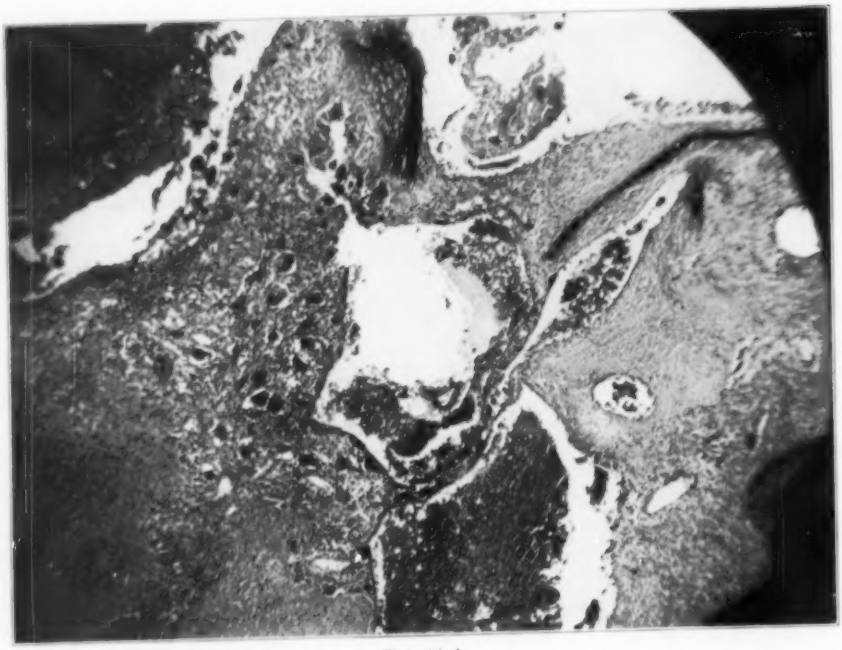

FIG. 11-A

(*See page 287*)

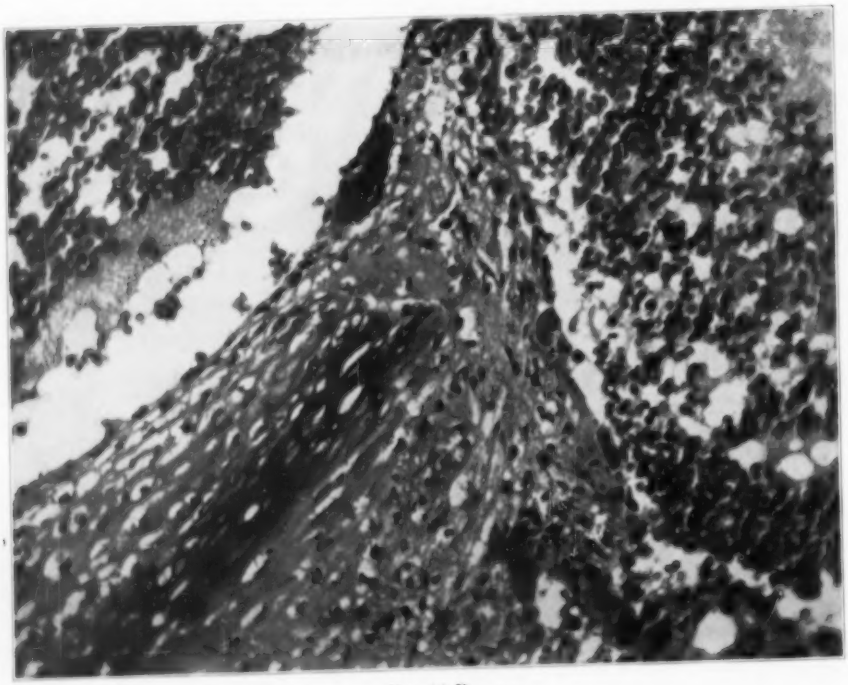

FIG. 11-B

(*See page 287*)

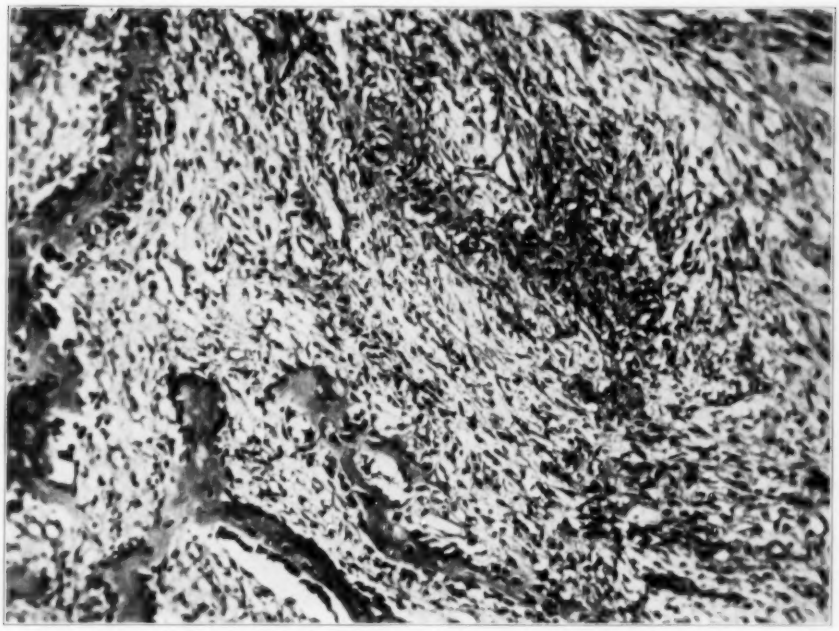

FIG. 12

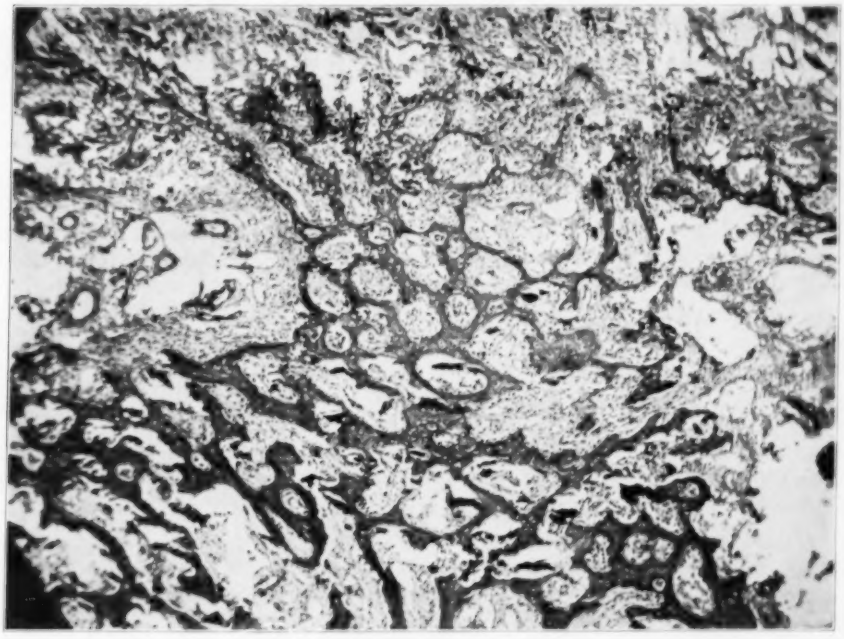

FIG. 13

Fig. 12 (× 142.5) and Fig. 13 (× 38): Photomicrographs showing osseous metaplasia from a fibrous-like stroma peripheral to the vascular center, producing the coarse trabeculations throughout the tumor seen in roentgenograms. (Courtesy of Armed Forces Institute of Pathology, Washington, D. C.)

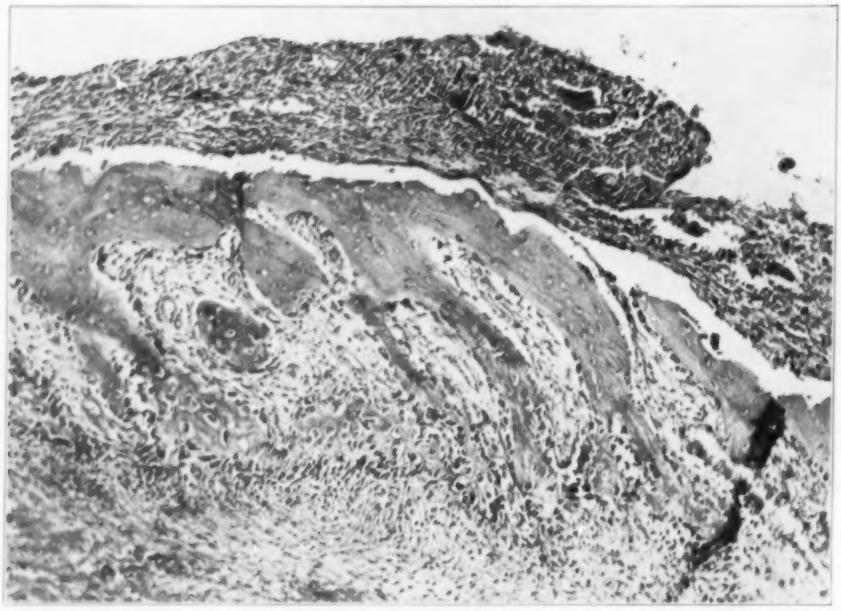

FIG. 14

Photomicrograph (× 85) showing peripheral shell of metaplastic bone covered by a layer of degenerating muscle bundles. (Courtesy of Armed Forces Institute of Pathology, Washington, D. C.)

considerably in size and are lined by a cellular layer of spindle and polyhedral cells (Fig. 9). Between the sinuses and surrounding them many large multinucleated giant cells are seen (which in areas form the sinus wall); not infrequently they occur within, giving an over-all impression of giant-cell tumor (Fig. 10). Commonly the lining of the cysts and the partitions of the blood lakes develop osteoid and narrow trabeculae of woven bone (Figs. 11-A and 11-B).

Peripheral to this area dense fibrous stroma predominates with scattered areas of hemorrhage and hemosiderin deposit (Fig. 12). Within this area osseous metaplasia from a fibrous-like stroma (Fig. 13) produces coarse trabeculations throughout the tumor and the domelike shell seen in the roentgenograms. The outer margins of the lesions are entirely composed of such metaplastic bone (Fig. 14) and have none of the characteristics of mature cortical bone. Covering the shell there is frequently a thin layer of scar tissue containing remnants of degenerating muscle fibers.

SUMMARY

The threefold title, although not entirely satisfactory, has been used, as the lesion has been commonly classified under these terms. Terminology is still in a state of flux, and the author does not have compelling reasons to force the choice of any given term, but he does feel that it is important to recognize the synonymous nature of the various terms already in the literature. The origin of the lesion—that is, whether it arises within or outside of bone—and the role played by trauma are still matters for discussion. The ability to recognize the somewhat unusual but characteristic features of the lesion is of practical importance, and description of these features has been the purpose of this paper. The tumor differs in many aspects—age of the patients, location, roentgenographic and microscopic appearance—from the genuine giant-cell tumor, and probably represents a reparative process following some as yet undetermined vascular disturbance about the periosteum

and surrounding tissues. It seems probable that such a growth might arise from rupture of a periosteal or nutrient vessel with subsequent seepage of blood and tumor formation. Such a hypothesis emphasizes the non-neoplastic nature of the disease and belies any convenient diagnostic term available.

NOTE: The author wishes to express his appreciation to Dr. Lent C. Johnson, Armed Forces Institute of Pathology, for his invaluable aid in preparation of this paper.

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DISCUSSION

DR. MARY S. SHERMAN, NEW ORLEANS, LOUISIANA: Dr. Garceau observed that solitary cysts are more common in the proximal end of the femur and of the humerus. I should like to ask, for my own information, whether he has ever seen a proved cyst in the distal end of either of these bones. I wonder also whether this observation is in agreement with his idea that cysts have a predilection for the more rapidly growing areas of bone. It is hard for me to believe that the "activity" of these cysts determines their recurrence rate. It seems to me that they would probably all be cured by total excision. But when a cyst extends directly to the epiphyseal plate in a young child, one must be careful with his surgery and a less complete cleaning out is preferable, in fact inevitable, even if it means repeated operations.

Dr. Thompson has given a timely discussion of a condition which receives too little attention. It is not a common condition and it is surprising to see incontrovertible evidence that the lesion can start entirely outside a bone; the very few I have seen appeared to arise within. Perhaps either location may be the site of origin. It is interesting that trauma seems to be important in initiating these lesions. It is, however, difficult to understand, if trauma is the principal factor, why these tumors are not more common and why they do not

(*Continued on page 306*)

COVERAGE PROBLEMS IN THE TREATMENT OF WRINGER INJURIES

BY CREIGHTON A. HARDIN, M.D., AND DAVID W. ROBINSON, M.D., KANSAS CITY, KANSAS

From the Department of Surgery, University of Kansas Medical Center, Kansas City

The descriptive term "wringer arm" was applied by MacCollum in 1938 to an injury in which the upper extremity is caught between the rollers of a power-driven washing machine. Such an injury, which occurs most frequently in childhood, produces damage primarily to the skin and soft tissues of the hand and arm. The severity of damage done to these structures depends on the length of time the arm is crushed between the moving rollers. The damage occurring in the younger age group is usually less severe because of a greater flexibility of joints and ligaments. Since the extent of injury cannot always be determined immediately, the prognosis should be guarded. Regardless of the initial appearance of the injury, the patient should be hospitalized and observed for at least forty-eight hours[2]. Immediate evaluation should include determination of nerve and tendon function distal to the site of injury and roentgenographic examination for possible fractures. Surface damage may range from a simple abrasion to an avulsion of the covering skin. In deeper tissues, on the other hand, such a direct force may produce an ecchymosis or a contusion without a break in the covering skin. Muscles, tendons, ligaments, and nerves may be crushed, frayed, or torn.

Conservative treatment should be employed in those cases in which viable skin covers the damaged area. Pressure dressings and elevation of the extremity will minimize the oedema of the injured limb. However, the skin may have been separated from its subcutaneous attachment by the mechanical action of the moving rollers. A collection of blood and serum beneath such a full-thickness area of skin considerably delays the re-establishment of good blood supply. When this type of injury is unrecognized and not

FIG. 1-A

FIG. 1-B

Fig. 1-A: Case 1. Wringer arm in a girl, aged six. Photograph made three weeks after injury. The wound was prepared for grafting by daily changes of moist saline pressure dressings.

Fig. 1-B: Photograph made after split-thickness skin graft coverage.

treated, the separated skin sloughs. Aspiration of blood and serum from delineated hematomata, whenever these are present, speeds primary wound healing with a minimum of fibrosis and prevents restricted motion in vital moving parts. Uncontrollable extravasation of blood into the damaged area has not been seen in any of the patients treated by us, nor have any of the injuries required incisional evacuation or direct ligation of bleeding vessels.

Venous thrombosis and lymphatic obstruction occur frequently. The arteries in the affected zone are less easily injured than the veins and continue to pump blood into the damaged area, thus causing engorgement. The final stage is necrosis. If a wringer injury has produced an avulsed flap which has been sutured back, the distal half of the flap usually dies and must be replaced at a later date. Farmer excised such an avulsed flap and trimmed off the subcutaneous tissue adjacent to the skin. This skin is then used as a free full-thickness skin graft. Such a graft can be used only when a suitable bed is present for its growth. The depth of injury will limit this type of coverage. A split-thickness skin graft satisfies all the requirements of surface coverage except that it is subject to shrinkage (Figs. 1-A and 1-B). Immediate pedicle-graft coverage is imperative in the event that bone, tendon, nerves, or joints are exposed and cannot be covered by a shift of local structures. Rotation flaps of local tissue are not suitable for wringer injuries, as the adjacent tissues are usually oedematous or show some evidence of injury with impaired blood supply. Tendon, nerve, and bone which does not have a suitable covering will become necrotic. If joints are left open, infection, secondary contracture of the joint capsule, and limited motion will develop. Immediate pedicle-graft coverage is needed in this type of surgery.

GENERAL PRINCIPLES GOVERNING THE PLANNING, MOBILIZATION, AND TRANSFER OF ABDOMINAL FLAPS

The thoracico-abdominal area is a most convenient site for pedicle-graft coverage of defects of the forearm and antecubital space. These flaps are usually based superiorly.

A smaller inferiorly based flap which includes a vascular pedicle, such as the superficial epigastric artery, provides adequate coverage for the hand and wrist. The flap should be one-third larger than the defect to allow for shrinkage. Generally the length of the flap should not exceed the width of its base by more than two and one-half times. The area from which the flap is to be mobilized should be free of scar, so that the blood supply should not cross the mid-line of the abdomen. In the elevation of the flap the incisions are carried down to the external oblique fascia, and the subcutaneous layer is sharply cut away from the fascia. A flap of equal thickness is thereby obtained. The full thickness of the abdominal skin and subcutaneous tissue must be used. Any attempt to thin the mobilized flap initially will impair its blood supply. Tissues must be gently handled with tissue hooks to avoid trauma. Bleeding vessels on the raw surface of the flap and the donor bed are clamped and secured with fine ligatures.

The defect in the abdominal wall from which the flap has been elevated can be closed by undermining and suture if there is sufficient laxity of the tissues. If the donor site is too extensive, an immediate coverage is done with a split-thickness skin graft. The flap is sutured to the arm defect with interrupted sutures without tension. Interrupted sutures are also used for all skin areas.

All skin surfaces on the axilla, arm, forearm, and hand should be kept apart with padding. Moderate pressure is applied to the flap to counteract venous stasis. We have found that a bandage and adhesive-tape fixation is more comfortable than a cast. Fixation should be accomplished in such a way that no tension is brought to bear on the sutured flap. The flap should have normal color and show evidence of capillary blanching upon pressure. One can safely sever the base end of the flap in about eighteen days. Multiple delaying procedures under local anaesthesia may be done to ensure a wider margin of safety.

FIG. 2-A

FIG. 2-B

FIG. 2-C

Fig. 2-A: Case 2. The patient was a woman, aged sixty, with a flap avulsion which exposed tendons and bone.

Fig. 2-B: Immediate flap coverage, based inferiorly on the superficial epigastric artery, was done.

Fig. 2-C: The photograph shows the result three months after injury. The base of the flap had been amputated serially eighteen days after grafting. The final revision had been made four weeks after injury.

All of the flaps used in this series of patients were of the open pedicle type. This implies that the ventral surface of the flap between the base and the surface sutured to the defect has no epithelial covering and is thus exposed to the danger of infection. Therefore, after severance of the base end of the flap, the freed arm or hand is placed in moist saline soaks for several days to facilitate surgical drainage.

A nicety of technique would call for a coverage of this open ventral area of the flap with a split-skin graft to close all open areas. One should allow sufficient redundancy of tissue toward the base end of the flap at the time of severance in order to provide for shrinkage. Final revision is delayed from three to four weeks to allow for maximum shrinkage.

Final defatting and removal of any peripheral scar must be done in stages. Only half of the area of a transferred flap can be thinned at one operative procedure. At least a month should be allowed to elapse before the procedure is repeated on the remaining half of the flap, if this is necessary. Sensation returns to these areas after varying periods of time, but usually not later than one year.

The following cases are presented in detail to illustrate the methods of flap coverage.

CASE 2. K. M., a sixty-year-old white female, was admitted to the University of Kansas Medical Center on August 8, 1949. Her left hand had been caught between the rollers of a washing machine for ten minutes.

FIG. 3-A

Case 3. A boy, aged five, sustained a bilateral wringer injury. The necrosis of the covering skin was apparent, but the depth of the injury was indeterminate.

FIG. 3-B

Three weeks after injury there was wound slough on the right arm exposing tendon, nerve, and blood vessels. The primary split-skin grafts did not take because of the depth of the injury.

Roentgenograms of the hand and wrist showed no evidence of fractures. The dorsal skin covering of the hand was avulsed and cortical bone and tendons were exposed. An irregular distally based flap remained, but showed evidence of impaired circulation (Fig. 2-A). The extensor tendon of the index finger was avulsed from its site of muscular origin. Definitive surgery consisted of peripheral débridement to a level where free arterial bleeding could be observed. Thrombosed veins were excised and bleeding vessels were ligated. An accessory incision was made proximally in the forearm to re-attach the avulsed muscle origin of the extensor tendon.

A retrograde flap, based inferiorly on the right inguinal area and incorporating the superior epigastric artery, was elevated. This flap measured ten by fifteen centimeters. The donor bed of the flap was closed by undermining and layer suture. The left elbow was flexed 90 degrees and was draped over the abdomen. The flap was sutured to the defect by means of subcutaneous interrupted No. 000 chromic catgut sutures. The contiguous skin edges were sutured with interrupted No. 0000 silk. The transferred flap was of normal color. Fixation of the arm in the desired position without tension on the flap was accomplished with a bandage and adhesive tape. Sixteen days after surgery the base end of the flap was severed one-half of its width (Fig. 2-B). Final severance was done on the eighteenth day. Moist saline dressings were applied to the hand for several days and the patient was then discharged.

FIG. 3-C

The left arm exhibited the same injury. Because of severe hemorrhage from the brachial artery, pedicle coverage was necessary.

FIG. 3-D

Coverage by superiorly placed broad-based flaps was done to cover both antecubital areas. Split-thickness skin grafts were used for the remainder of the distal granulation tissue.

Four weeks after injury the patient returned for defatting and revision of the flap.

When she was seen three months after injury, she had a normal coverage of the dorsum of the hand (Fig. 2-C). With active flexion she could bring all the finger tips to within one centimeter of the distal palmar crease. The range of extension was normal.

In this case, the immediate application of an abdominal flap provided coverage for exposed structures. Primary healing occurred with a minimum of residual dysfunction. If active motion is begun as soon as the flap is severed, oedema subsides and normal ranges of motion return with use. The initial use of the position of function will minimize the late unpredictable limitations of motion.

CASE 3. W. D., a five-year-old white male, was admitted to the University of Kansas Medical Center on June 20, 1949. Both his arms had been caught between the rollers of a washing machine for thirty minutes. The covering skin of the forearm and antecubital space was necrosed (Fig. 3-A). The left side measured

FIG. 3-E

Photograph made after the flaps had been defatted. There was full range of motion at the elbow. One year after injury there was no residual deformity and there was complete return of nerve function.

four by eight inches and the right four by four inches. Roentgenograms gave no evidence of fractures. Bilateral paralysis of the radial, ulnar, and median nerves was present. The patient was taken to surgery where the necrotic skin was excised.

The depth of excision included the fascia of the forearm. The exposed muscle bundles were of normal color. The extent of peripheral excision was determined by the presence of free bleeding from cut skin edges. Immediate coverage was accomplished by split-thickness skin grafts. The arms were splinted in full extension with a pressure dressing. The wrist was placed in a "cock-up" splint and the hand in the position of function.

The split grafts underwent gradual necrosis during the next two to three weeks. Tendons, arteries, and nerves of the forearm became exposed (Fig. 3-B). A severe hemorrhage occurred from the left brachial artery which required an immediate transfusion of 1,000 cubic centimeters of whole blood. Local suture of the vessel controlled the bleeding (Fig. 3-C).

The following day the patient was subjected to surgery and bilateral thoracico-abdominal flaps were mobilized to cover both antecubital areas. The flaps were based superiorly. The right flap measured ten by fifteen centimeters and the left fifteen by twenty-five centimeters. The donor defects of the flaps were covered with split-thickness skin grafts. The remainder of the distal granulations of the forearm not covered by the flap were covered with split-thickness grafts (Fig. 3-D). Nineteen days after operation both flaps were completely severed and the freed arms were placed in moist saline dressings. The patient was discharged from the hospital five days later in a dry dressing. Physical therapy was continued in the Out-Patient Department and the patient was given protective splinting.

Three months after injury, defatting and revision of the flaps were done. One year after injury, there was full range of motion of the elbows and complete return of nerve function (Fig. 3-E).

The early necrosis of the covering skin was readily apparent, but the depth of injury was indeterminate. The gradual necrosis of the initially applied split grafts was caused by the deeper tissue damage. The use of thoracico-abdominal flaps provided necessary coverage for the exposed tendons, nerves, and blood vessels. The use of splints to maintain the proper position of the wrist and hand until nerve function returns cannot be overemphasized. Bilateral flap coverage with its attendant immobilization was remarkably well tolerated in spite of the patient's being so young.

DISCUSSION

Definitive reconstructive surgery should be deferred until all inflammatory induration has subsided and the degree of deformity can be ascertained. Operating on indurated tissue only produces a "summation" of scar.[1] The time interval, however, may be shortened if the wound treatment has been ideal and if primary healing has occurred. One would think that this type of injury would be especially prone to the development of traumatic arterial spasm, not only because of the direct crushing type of force, but also on a reflex basis. However, none of the patients seen by us exhibited this complication.

Clinically it is often difficult to determine the viability of the covering skin over an injured area. Quite often the gross appearance and absence of bleeding on excision will be criteria enough for surgical removal and immediate replacement of the damaged skin. Ross has reported an absence of sensation to pin-prick as an aid in delineating the extent of non-viable skin in burns of the hand. However, in deeper damage, such as is seen in a wringer arm, any attempt to provide adequate coverage short of a pedicle-flap replacement will prove useless.

Surgical débridement when indicated should be conservative. In this series penicillin was early given prophylactically. Specific antibiotics, after sensitivity had been determined by wound culture, were given to all patients with definitely open infected wounds. Granulating surfaces were prepared for split-thickness skin-grafting by daily changes of fine-mesh, moist saline pressure dressings. Enzymatic debriding agents, such as streptokinase-streptodornase and crystalline trypsin, have proved to be of no value in our hands in speeding up the separation of necrotic skin and fascia. These agents do not possess a collagenase activity, but are in the main fibrolysins.

Special attention was paid to the position of function concerning all procedures on the hand. Exercise and physical therapy were instituted as soon as the grafts were stable.

ANALYSIS OF CASES

Our series consisted of thirty-five patients with wringer injuries. Thirty of these were under six years of age and the remainder were adults. The time between injury and treatment ranged from one-half hour to 120 days. Twenty of these patients required some type of skin-grafting procedure. Pedicle-flap coverage was required in eight patients because of exposed tendon or bone. No fractures were seen in any of these patients. The loss of covering skin in the younger age group is usually limited to the forearm or axilla. One patient, aged two, was caught between the rollers of a wringer for two hours. Major damage to the skin, muscle, and axillary vessels necessitated a subcapsular amputation of the right arm. The remainder of the patients in the younger age group showed few late residual deformities. In the adult group the injury was limited entirely to the skin of the dorsum of the hand. Flap avulsion or late full-thickness loss of skin was characteristic of the damage in these patients. The sequelae of injury were more pronounced and were usually manifested by restricted motion in the metacarpophalangeal and distal interphalangeal joints. Early placement of the hand in the position of function did much to minimize this late complication.

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OBSTACLES TO REDUCTION IN SUBTALAR DISLOCATIONS

BY BALDO LEITNER, M.D., VIENNA, AUSTRIA

From the Unfallkrankenhaus, Wien *

In the twenty-five years from December 1925 to the end of 1950, 449,041 patients were treated at the *Unfallkrankenhaus*. Among these patients there were 4,125 cases of traumatic dislocation, of which forty-two (1 per cent.) were recent subtalar dislocations. A detailed report of these cases has been published elsewhere[2].

The cases were divided as follows:

Medial dislocations	36
Lateral dislocations	5
Posterior dislocations	1

We did not observe an anterior dislocation.

After an exact diagnosis of a dislocation, the surgeon is above all interested in treatment and prognosis and particularly in the treatment of those dislocations in which some obstruction hinders or prevents normal closed reduction.

TABLE I

SUMMARY OF CASES

Type of Dislocation	Closed Reduction	Open Reduction		Total
		Performed because of Subtalar Dislocation	Performed because of Concomitant Injury	
	(*No. of Patients*)	(*No. of Patients*)	(*No. of Patients*)	
Medial	32	3	1	36
Lateral	5	0	0	5
Posterior	1	0	0	1
Total	38	3	1	42

Four of our forty-two patients showed such an obstruction due to the nature of the dislocation. Three of these (8 per cent.) occurred among the thirty-six medial dislocations and one (20 per cent.) among the five lateral dislocations. In one medial dislocation the obstruction was due to concomitant subluxation of the talus at the ankle joint.

In a review of the literature the author was able to find 162 cases of medial dislocation, of which thirteen (8 per cent.) showed obstruction, and fifty-nine cases of lateral dislocation of which nine (15 per cent.) showed obstruction.

As can be seen from Table I, four of the thirty-six medial dislocations had an open reduction while all five of the lateral dislocations as well as the only posterior dislocation in the series were reduced by manipulation. It is worth noting that we were able to reduce one of the lateral dislocations by Böhler's method without recourse to surgery, in spite of an obstruction caused by the tendon of the tibialis posterior.

In three of our four cases open reduction was necessary because of the nature of the dislocation. In two of these open reduction was undertaken because of impaction of the navicular in the fractured head of the talus and in one because of impaction of the ligamentum cruciatum cruris. In the fourth case, however, open reduction was necessary

* Direktor: Professor Lorenz Böhler.

because of an accompanying subluxation of the talus, around which the tendons of the musculi peronaei had become twisted.

Obstructions in Medial Dislocations

Open reduction was required in the following three cases of our thirty-six medial dislocations.

CASE 1. F. T., a civil servant, was a woman, twenty-three years old. On September 15, 1934, she fell some three meters from a ladder and was admitted to the *Unfallkrankenhaus* thirty minutes later.

FIG. 1-A

FIG. 1-B

Figs. 1-A and 1-B: Case 1. Roentgenogram and drawing of a medial and slightly posterior subtalar dislocation. The displacement amounted to about one and one-half times the width of the navicular. An obstruction was caused by the cruciate ligament, which was replaced during open reduction. This obstacle to reduction could have been overcome by a suitable technique, that is, by grasping the heel and applying manual traction on the foot with alternate dorsiflexion and plantar flexion. (Fig. 1-B used by permission of *Ergebnisse der Chirurgie und Orthopädie*, **37**: 570, 1952.)

Clinical findings on admission: The right foot was fully inverted and somewhat displaced medially and posteriorly. The sole faced the contralateral extremity. The lateral malleolus was extremely prominent. Distal to it there was an abnormal round projection which corresponded to the projecting head of the talus. Over both, but particularly over the head of the talus, the skin was stretched to the point of tearing and was blanched as a result of the circulatory disturbance. The medial malleolus was not visible and was scarcely palpable, but distal to it there was a long projection—the medial side of the calcaneus—and the sustentaculum tali was easily felt. Distal to it the extremely prominent tuberosity of the navicular was also felt. Active movement of the foot was practically impossible, but passive dorsiflexion and plantar flexion were almost complete. The pulse of the dorsalis pedis was palpable.

Roentgenographic findings on admission: X-rays showed a subtalar dislocation of the right foot. The foot was dislocated medially by about one and one-half times the breadth of the navicular, as well as inferiorly and posteriorly (Fig. 1-A). There was also a fracture of the processus posterior tali.

Treatment and progress: Attempts at closed reduction by means of extension of the foot and by strong plantar flexion over a wooden wedge were unsuccessful. Following this, traction was applied by means of a screw-traction apparatus with a clamp on the calcaneus and a wire through the metatarsals; next traction was applied by means of a band over the leg, with the wire still in position. These attempts, too, were unsuccessful. Chopart's joint was then opened under local anaesthesia by means of a long incision over the head of the talus.

FIG. 2-A

FIG. 2-B

Case 2. Roentgenogram and drawing of a medial subtalar dislocation with impaction of the navicular into the medial side of the head of the talus. The lateral edge of the navicular had penetrated some three millimeters into the head of the talus. In this case the force which caused the dislocation had spent itself in the formation of the impaction. It should have been possible to obtain a closed reduction by an increase in the degree of adduction and extension, that is, by grasping the heel and applying manual traction on the foot. (Fig. 2-B shows a right foot, but it was actually the left foot which was involved.) (Fig. 2-B used by permission of *Ergebnisse der Chirurgie und Orthopädie*, **37**: 570, 1952.)

The head of the talus lay immediately under the skin and it was seen that a piece of the articular cartilage measuring about fifteen by fifteen millimeters was missing from the medial aspect of the plantar surface. The extensor muscles of the toes were displaced medially and the muscle belly of the extensor hallucis brevis was torn. The distal lateral limb of the cruciate crural ligament passed inferiorly and medially to the neck of the talus and so prevented reduction (Fig. 1-B). After division of the ligament, the head of the talus was freely movable and the dislocation was easily reduced. The torn ligaments were cleaned with scissors and forceps. A drain was placed in the sinus tarsi and after closure of the skin a plaster boot was applied which was immediately split and a window was made over the drain. The drain was removed on the day following and on the second day after operation all dressings were removed from the wound. Dry gangrene of the wound edge set in and was followed by infection of the ankle joint. The period of immobilization was twenty-eight weeks. The patient obtained 10 degrees of plantar flexion and no inversion or eversion of the foot.

The patient was hospitalized for 256 days and was followed in the Out-Patient Department for a period of 109 days. She was therefore under observation for a total of 365 days.

Clinical findings at follow-up examination: Sixteen years after the accident the patient had a tendency to limp on the right foot. There was no active movement of the toes in the neutral position and passive movement was slightly limited. The ankle was greatly thickened. There was no active movement in the ankle joint. She aso complained of a tendency to swelling of the joint, particularly in the evening and in the summer.

She was awarded compensation on the basis of 25 per cent. disability.

Roentgenographic findings at follow-up examination: There was bony ankylosis of the ankle joint. The foot was in 10 degrees of plantar flexion. There was no inversion or eversion of the foot.

In our opinion the obstacle to reduction in this case could have been overcome without operation by a suitable technique such as grasping the heel and applying manual traction at the foot, with alternate dorsiflexion and plantar flexion. Closed reduction would have been extremely desirable in this case, because of the dry gangrene of the wound edge which set in following operation and which led to infection of the joint and finally ankylosis.

CASE 2. J. E., a laborer, twenty-six years old. On October 20, 1947, this man fell when a fourth-story ceiling collapsed. He was admitted to our Hospital forty-five minutes later.

Clinical findings on admission: Findings were similar to those in Case 1, but in addition this patient

FIG. 3-A

FIG. 3-B

Case 3. Roentgenogram and drawing of a medial subtalar dislocation with a concomitant shearing-off of a flake from the head of the talus. The navicular was impacted four millimeters into the head of the talus. In this case, in contrast to Case 2, the force causing the dislocation and impaction continued to act; this led to the shearing-off of the flake. This dislocation could have been reduced by manipulation as described in Case 2. (Fig. 3-B used by permission of *Ergebnisse der Chirurgie und Orthopädie*, **37**: 570, 1952.)

had a contusion of the right side of the thorax and of the pelvis as well as wounds and excoriations of the brow and nose and of the right heel.

Roentgenographic findings on admission: Subtalar dislocation of the left foot medially and slightly posteriorly, with a depression on the medial side of the head of the talus. The lateral edge of the navicular had penetrated about three millimeters into the head of the talus.

Treatment and progress: Under ether anaesthesia several attempts were made without success to effect a closed reduction. A Steinmann pin was driven through the calcaneus, a Kirschner wire was passed through the bases of the metatarsals, and traction was applied by means of a screw-traction apparatus, but again without success. Upon exposure for operative reduction of the dislocation it was seen that there was a depression three millimeters deep on the medial aspect of the head of the talus. The lateral edge of the navicular was impacted in this depression and thus prevented reduction (Figs. 2-A and 2-B). The dislocation was easily reduced by means of a gouge. A drain was placed in the sinus tarsi and the skin was closed. The plaster boot was split and a window was made over the drain. The drain was removed on the day following operation and dressings for the wound were discontinued from the second day after operation. Three weeks after operation a walking cast was applied. The duration of immobilization was ten weeks in all. Healing in this case was by first intention.

The patient was hospitalized for thirty-five days and was followed in the Out-Patient Department for a period of 127 days, a total of 162 days.

Clinical findings at follow-up examination: Three years after the accident there was no limp and the toes were freely movable. Movement in the talocalcaneal joint was reduced by 33 per cent. Movement in the ankle joint was from 65 to 110 degrees (in the right foot, from 65 to 120 degrees). There was a tendency to pain and swelling in the evening. The scar showed no reaction.

The patient received no compensation.

Roentgenographic findings at follow-up examination: A small degree of arthrosis was present in the talonavicular joint.

In this case it should have been possible to increase the degree of adduction by grasping the heel and applying manual traction at the foot to overcome the obstacle to reduction and so effect a closed reduction.

Case 3. J. K., a laborer, fifty-one years old. This patient was buried under debris and was admitted to our Hospital thirty minutes later on October 28, 1949.

Clinical findings on admission: Findings in this case were similar to those in Case 1, but in addition the patient had a separation of the symphysis pubis.

Roentgenographic findings on admission: X-rays revealed a subtalar dislocation of the right foot medially and a little posteriorly (Figs. 3-A and 3-B). A flake of about fourteen by seven millimeters had been shorn from the medial side of the head of the talus. The navicular had penetrated some four millimeters into the head of the talus and had become impacted.

Treatment and progress: After attempts at closed reduction under local anaesthesia had failed, we proceeded with operative reduction under nitrous oxide anaesthesia, because of the similarity roentgenographically of this case with Case 2. The operative technique also was similar to that in Case 2. It is worth recording that in this case alone of our thirty-six cases of medial dislocation, the dislocation recurred after reduction. This was seen on the x-ray made after application of the plaster cast. The plaster was removed, the dislocation was reduced by manipulation, and fresh plaster was applied. Further treatment was similar to that in Case 2.

FIG. 4

Drawing of the head of the talus penetrating the belly of the extensor digitorum brevis, described by Wendel in 1905 as an obstacle to reduction in a case of medial subtalar dislocation. Even this dislocation could have been reduced by manipulation, that is, by powerful traction at the foot. (Although the drawing shows a right foot, it was actually the left foot which was involved.) (Used by permission of *Ergebnisse der Chirurgie und Orthopädie*, **37**: 570, 1952.)

The patient was hospitalized for seventy-one days and was followed in the Out-Patient Department for a period of 169 days—a total of 240 days.

Clinical findings at follow-up examination: One year after the accident there was no limp and the toes were freely movable. Movement in the subtalar joint was reduced by 33 per cent.; movement in the ankle joint was from 75 to 120 degrees (in the left foot, from 65 to 130 degrees). The scar showed no reaction. The patient felt pain when the weather changed and there was persistent pain at the symphysis pubis.

He was awarded compensation on the basis of 30 per cent. of disability.

Roentgenographic findings at follow-up examination: A small degree of arthrosis was present in the talonavicular joint.

In this case, in contrast to Case 2, the force which caused the dislocation and impaction continued to act and so caused the shearing-off of the flake. Today, if the roentgenogram as well as the unsuccessful attempts at closed reduction indicated an impaction of the navicular in the damaged head of the talus, we should attempt reduction by means of full adduction of the foot with simultaneous traction applied by grasping the heel.

For the sake of completeness another obstacle to reduction in a case of medial subtalar dislocation should be mentioned. This case is taken from the literature. In 1905 Wendel saw at operative reduction of a dislocation that the head of the talus had pierced the extensor digitorum brevis and that the muscle belly surrounded the neck like a buttonhole (Fig. 4). He effected reduction after increasing the split in the muscle. In our opinion even this obstacle could have been overcome by a suitable technique, such as powerful traction at the foot.

Obstacles in Lateral Dislocations

Only one of our five lateral dislocations was irreducible at first because of the position of the tendon of the tibialis posterior, but even this was reduced by the method described by Böhler.

Case 4. J. G., a laborer, forty-eight years old. On December 17, 1940, this man fell from a scaffolding and was admitted to the author's Hospital twenty-five minutes later.

Clinical findings on admission: The left foot was fully everted and was lying against the side of the leg. It was displaced laterally and posteriorly. The head of the talus projected from the dorsum of the foot, distal to the medial malleolus. The skin around the medial malleolus and the head of the talus was tightly stretched and blanched. Active movement of the toes was reduced by 66 per cent. and active movement at the ankle was limited entirely. The lateral malleolus was extremely sensitive to pressure and there was crepitation. The pulse in the dorsalis pedis was palpable.

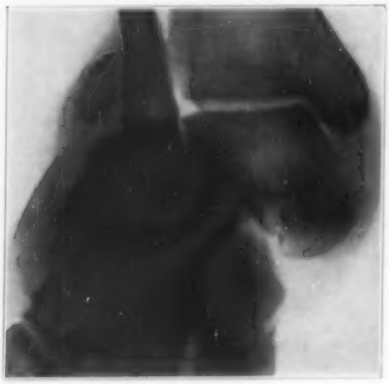

Fig. 5-A

Fig. 5-B

Case 4. Roentgenograms of a lateral inferior and posterior subtalar dislocation. The tendon of the tibialis posterior had become hooked around the talus in such a way that it was lying lateral to the neck (see Figs. 5-C and 5-D). There was a concomitant fracture of the lateral malleolus which was displaced upward, as well as a fracture of the processus posterior tali. Closed reduction was effected by Böhler's method. (The left foot was actually the one involved.) (Figs. 5-A and 5-B used by permission of *Ergebnisse der Chirurgie und Orthopädie*, **37**: 557, 1952.)

Fig. 5-C

Fig. 5-D

Fig. 5-C: Drawing showing the pathological position of the tendon of the tibialis posterior in the same case. The tendon was carried laterally with the dislocation, slipping over the head of the talus so that it came to lie laterally to the neck of the talus.

Fig. 5-D: In the lateral view it was seen that the tendon passed dorsally from its insertion into the medial cuneiform and navicular over the joint cavity of the navicular and was lying on the lateral side of the neck of the talus. The tendon had slipped from its normal groove at the distal end of the tibia and had passed over the medial to the anterior surface of the tibia. (Figs. 5-C and 5-D used by permission of *Ergebnisse der Chirurgie und Orthopädie*, **37**: 569, 1952.)

FIG. 5-E

FIG. 5-F

Fig. 5-E: Closed reduction was effected by grasping the heel and applying manual traction on the foot while the foot was fully dorsiflexed. In this way the tendon was freed from the obstruction and slipped from the lateral side of the neck of the talus to the head of the bone.

Fig. 5-F: When the foot was pushed medially the reduction was completed and the tendon regained its normal position. (Figs. 5-E and 5-F used by permission of *Ergebnisse der Chirurgie und Orthopädie*, **37**: 569, 1952.)

Roentgenographic findings on admission: Roentgenograms revealed a lateral inferior and posterior subtalar dislocation of the left foot. (Our other four lateral dislocations were displaced anteriorly.) The lateral malleolus was fractured and displaced medially. The processus posterior tali was also fractured.

Treatment and progress: An attempt at closed reduction was made under local anaesthesia with full flexion of the hip and knee, but, since the patient did not completely relax, general anaesthesia had to be used. An unsuccessful attempt was then made to increase the displacement of the foot and at the same time to push the foot medially and anteriorly. Following this an attempt was made to apply traction to the foot and countertraction in the long axis of the leg, after which manipulation was repeated with simultaneous inversion and eversion of the foot, but again without success. Reduction was achieved when the foot was placed in complete dorsiflexion and then pulled anteriorly and pushed medially, so that the tendon slipped back dorsally. A plaster boot was applied which was immediately split. The period of immobilization was six weeks.

The patient was hospitalized for fourteen days and was followed in the Out-Patient Department for a period of 126 days—a total of 140 days.

Clinical findings at follow-up examination: When he was seen ten years after the accident, he had an obvious limp on the left. Active movement of the toes was slightly limited, but passive movement was free. Movement in the subtalar joint was almost completely limited. Movement in the ankle joint was from 80 to 110 degrees (in the right foot, from 70 to 120 degrees). Pain was present particularly in the morning and a tendency to swell was noticed chiefly at night.

The patient was awarded compensation on the basis of 30 per cent. disability.

Roentgenographic findings at follow-up examination: A severe degree of arthrosis was seen in the anterior and posterior talocalcaneal joints as well as the cuneonavicular joint.

In this case, the increase in length of the course of the tendon caused by the accident must have been about three centimeters, according to measurements made on an anatomical preparation. Since this tendon has a powerful insertion into the plantar aspect of the navicular and medial cuneiform and gives off a fibular attachment as well, we must assume that this case is not one of detachment of the insertion. The increase in length can therefore have come only from that part of the tendon proximal to the site of injury; the tendon was displaced from its normal groove at the distal end of the tibia and passed diagonally—mediolaterally—over the distal end of the tibial shaft. That part of the tendon which inserted into the navicular and medial cuneiform was carried laterally with the dislocation, with the result that the tendon slipped laterally over the head of the talus. It then passed from the plantar surface of the navicular dorsally over the joint cavity of

that bone, lateral to the neck of the talus, and from there diagonally to the medial side of the distal end of the tibia.

At the follow-up examination of this man particular attention was paid to the course of the tibialis posterior tendon, but it was difficult to determine whether this tendon lay in its normal groove at the distal end of the tibia or immediately beside it. It was definitely established, however, that the tendon in this area could be moved about one millimeter, whereas in the normal person this is impossible. This may be considered proof that the tendon sheath as well as the ligamentum laciniatum had been damaged in this area, from which it is to be assumed that this ligament was torn by the lateral dislocation of the calcaneus.

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DISCUSSION

Subperiosteal Giant-Cell Tumor

(*Continued from page 291*)

appear with great regularity in such sites as the tibial shaft, patella, and olecranon, which are always being bumped. Furthermore, why do they not appear after fractures or surgical procedures which, in addition to inflicting trauma, also rupture vessels? It would be interesting to study these patients from the hematological point of view, to see whether "bone aneurysms" present an unusual response to trauma which is dependent upon a constitutional disturbance. The terms "subperiosteal giant-cell tumor" and "ossifying subperiosteal hematoma" should surely be discarded. As Dr. Thompson pointed out, the lesion has absolutely no relation to a neoplasm. It has even less resemblance to an organizing hematoma. Although we do not know the etiology of the lesion, the term "bone aneurysm" describes its appearance and behavior and has the virtue of not being entirely misleading.

Dr. Murray M. Copeland, Washington, D. C.: Dr. Garceau and Dr. Gregory in discussing unicameral bone cysts have reviewed for us the pathology, the natural history, and the complications which arise in this condition. Dr. Bloodgood in the 1920's and Dr. Geschickter and I in the early 1930's pointed out the existence of an active phase in the development of bone cysts which we spoke of as a giant-cell variant of bone cysts. We pointed out that treatment in giant-cell variants should be the same as in giant-cell tumors. Such cysts should be thoroughly curetted and chemically cauterized and the defect should then be filled with bone chips. I feel that in the younger age group we are more apt to have an active giant-cell variant of a bone cyst. This complicates the treatment, because the cysts are frequently very near the epiphyseal line. I agree with the authors in their treatment of the quiescent simple bone cyst.

Dr. Thompson gave an excellent presentation of subperiosteal giant-cell tumor. When the last edition of our book was published, we had seen four patients with this tumor. We have now seen seven patients with such lesions. The last patient had an interesting clinical course. The lesion was in the humerus of a young woman who had been operated upon for thyroid cancer. The bone lesion appeared one and a half years later. It showed the usual periosteal reaction, but there was perforation of the cortex, which raised the question whether this was an atypical metastasis. We submitted the patient to radio-active iodine tracer studies, but no activity was noted in the bone lesion. In operating upon this girl, we found a subperiosteal osteoclastasia and after surgery this patient did very well.

CENTRAL DISLOCATION OF THE FEMORAL HEAD TREATED WITH MOLD ARTHROPLASTY

BY ANDERS WESTERBORN, M.D., GÖTEBORG, SWEDEN

From Sahlgrenska Sjukhuset, Kirurgiska Klinik II, Göteborg

Pelvic fractures with central dislocation of the femoral head are not uncommon. In a series of 500 cases of pelvic fracture reported by the author in 1928, the acetabular floor was fractured in sixty-four. In twenty-one of the 500 fractures, the femoral head was dislocated centrally to a varying degree. Central dislocation of the femoral head had thus occurred in not quite 5 per cent. of the entire series. In the series reported by Wilenius in 1943, there was a frequency of about 10 per cent. (forty-five out of 428).

Prognosis

The prognosis of acetabular fractures, especially of those with central dislocation treated by conservative methods, is poor. Even after the healing of the fracture, the range of motion of the joint gradually decreases (especially the range of abduction, adduction, and rotation), and increasing pain may considerably disable the patient. Fifty-one cases of acetabular fracture which were included in the 1928 series were reviewed (Table I). Of these cases, only twenty-six patients (51 per cent.) recovered the working capacity which they had had previous to injury, while twenty-five were more or less disabled. Of the thirty patients with acetabular fractures without central dislocation of the femoral head, twenty recovered the working capacity which they had had prior to injury; of the twelve patients with slight central dislocation, five recovered the working capacity which they had had prior to injury; only one of the nine patients in whom the dislocation had been classed as *complete* was symptom-free. The interval between the accident and the follow-up examination was at least two years.

Armstrong and Urist also reported poor results in central dislocation of the femoral head treated by conservative methods.

Persistent symptoms are for the most part due to severe osteo-arthritis which often results from such fractures, and are, therefore, only partially due to the central

FIG. 1-A

Fig. 1-A: Case 1. A man, twenty-five years old, had been in a motor-car accident on July 22, 1949, and had sustained a pelvic fracture with central dislocation of the femoral head of the left hip and an injury to the sciatic nerve. When he entered *Sahlgrenska Sjukhuset* on August 19, 1949, he had paresis of the left lower extremity and central dislocation of the femoral head (Fig. 1-A). An attempt at open reduction of the dislocation at another hospital had resulted in wound infection which contra-indicated arthroplasty for the time being. During bed rest the wound healed and the paresis gradually passed off. Despite physical therapy, the hip joint gradually became stiff, so that the range of motion decreased to 20 to 30 degrees of flexion with complete loss of abduction and rotation.

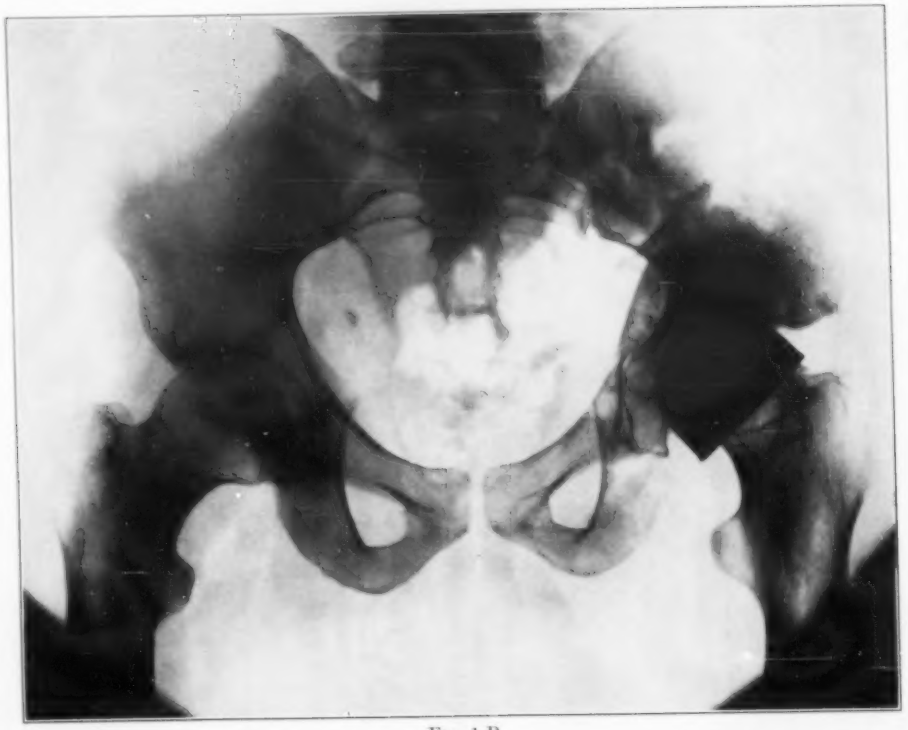

FIG. 1-B

FIG. 1-C

Figs. 1-B and 1-C: Case 1. On March 9, 1950, the patient underwent mold arthroplasty of the hip. The femoral head lay so deeply in the pelvis that the greater trochanter rested against the margin of the acetabulum. As the fracture had already begun to heal, reposition of the fragments was impossible. Projecting bone edges were removed, and the upper margin of the acetabulum was resected in order to secure better abduction. The Vitallium mold chosen was large enough to fill the entire aperture of the acetabulum, but it did not quite reach the bottom of the fractured joint cavity. Because of the large size of the mold, the central dislocation of the femoral head was considerably diminished (Fig. 1-B).

During the postoperative course, the patient received the after-treatment consistent with mold arthroplasty according to the Smith-Petersen technique. He was discharged from the Hospital on June 20, by which time the paresis had completely disappeared. He was able to walk without difficulty, and the range of motion in the joint was practically normal. On July 10, 1951, he began to work in an office. When he was seen at follow-up examination on April 4, 1953 (three years after the operation), he had no pain in his hip and had good stability; he had normal extension, abduction, and adduction. Flexion of the hip was to 90 degrees (Fig. 1-C). He could walk well. The patient is at present working in a factory.

FIG. 2-A

FIG. 2-B

Figs. 2-A and 2-B: Case 2. A woman, forty-six years old, had had an accident on December 14, 1951, which resulted in the splitting of an unusually thin floor of the acetabulum and central dislocation of the femoral head (Fig. 2-A). As an attempted closed reduction and traction proved to be unsuccessful, the patient was subjected to arthroplasty on December 19, 1951. The acetabulum was reshaped and some loose fragments were removed. The femoral head was left intact and was covered with a large mold. The mold fitted the acetabulum well and decreased to a considerable degree the central dislocation.

The patient left the Hospital on February 23, 1952, at which time she was able to walk well without support and had recovered practically full motion in the joint without pain. She returned to her work as a waitress in June 1952 and has had full working capacity since October 1952. When seen in November 1953, nearly two years after the accident, she had normal motion in the hip joint, no pain, and normal working capacity (Fig. 2-B).

FIG. 3-A

(*See page 310*)

dislocation of the femoral head *per se*. The femoral head is often enclosed to a considerable extent in large masses of callus. This new-bone formation is probably caused by the healing of the acetabular fracture fragments in a more or less dislocated position. If there is no dislocation or if there is only slight dislocation, callus formation is less pronounced. Rupture of the joint capsule also favors abundant callus formation.

Treatment

The treatment of central dislocation, at least if the femoral head and the acetabular fragments are markedly dislocated, presents considerable difficulty. Closed reduction and subsequent treatment in extension will hardly ever give satisfactory results. It is seldom possible by manipulation alone to loosen the dislocated and impacted fragments of the pelvis; the femoral head thus remains dislocated. Open reduction is a major operation and

FIG. 3-B

FIG. 3-C

Figs. 3-A, 3-B, and 3-C: Case 3. A man, sixty-two years old, had been involved in an accident on May 22, 1952, and had sustained a pelvic fracture with central dislocation of the femoral head (Fig. 3-A). After attempts at closed reduction had failed, the patient was subjected to arthroplasty on May 28, 1952. The reposition of the acetabular fragments was impossible. Only some of the projecting fragments were removed, and the joint surface of the acetabulum was made smooth. The femoral head was covered with a large mold. The central dislocation was decreased to a certain extent (Fig. 3-B), and the distance between the trochanter and the upper edge of the acetabulum was considerably increased.

The patient was discharged on August 30, at which time he was able to walk without support, and he had practically normal painless motion in the joint. In January 1953, he returned to his work as a factory foreman. At follow-up examination in August 1953, he had some pain in the hip, normal motion in the joint, and could walk well without support (Fig. 3-C). He was then working in a factory.

FIG. 4-A

FIG. 4-B

Figs. 4-A and 4-B: Case 4. A man, thirty-one years old, was involved in a motorcycle accident on June 23, 1952; and he had sustained a severe pelvic fracture with central dislocation of the hip and fracture of the anterior and posterior part of the pelvic ring. Because of thrombosis and pulmonary complications, operative treatment had to be delayed until July 31, when he was subjected to mold arthroplasty.

He left the Hospital on November 13, 1952. At this time he was able to walk well with the aid of a cane, but the range of motion of the joint was considerably limited. At follow-up examination in October 1953, fourteen months after the operation, he was walking without support and had nearly normal motion in a painless joint. He was satisfied with the result of the operation, and he began to work in a factory.

FIG. 5-A

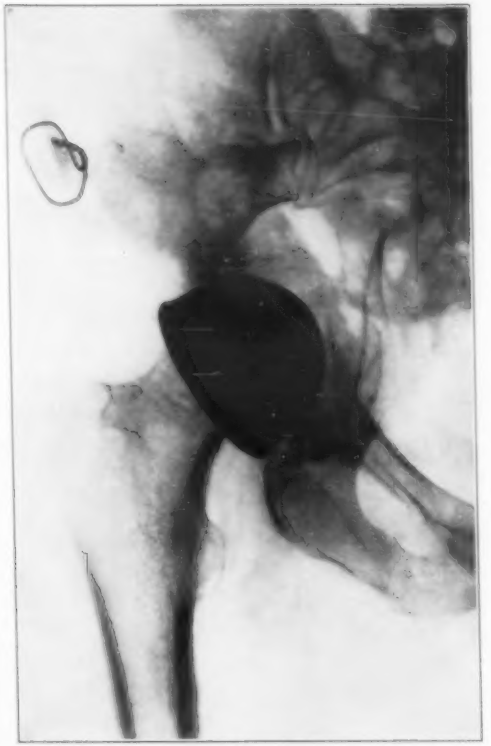

FIG. 5-B

Figs. 5-A and 5-B: Case 5. A woman, forty-five years old, as the result of an accident on October 10, 1952, had sustained a pelvic fracture with central dislocation of the femoral head (Fig. 5-A). After attempts at closed reduction and treatment in extension had failed, the patient was subjected to arthroplasty on October 28. Only slight repositioning of the acetabular fragments was possible. The acetabulum was reshaped and some loose fragments were removed. The femoral head was covered with a large Vitallium mold. The mold considerably decreased the central dislocation of the femoral head. The patient had a slow recovery because of ossification of the soft parts near the joint. After the removal of these, satisfactory and painless motion in the joint was attained. When she left the Hospital in March 1953, she walked well and was satisfied with the result. At follow-up examination on November 30, 1953, she had pain and reduced motion in the hip joint. Roentgenograms showed ossifications near the joint. This patient had had, in addition to the fracture of the acetabulum, an extensive comminuted pelvic fracture. This might yet influence the prognosis.

TABLE I

THE PROGNOSIS OF FRACTURES OF THE ACETABULUM TREATED BY CONSERVATIVE METHODS

(Follow-up Examination of Fifty-one Cases)

Fracture of the Acetabulum	No. of Cases	Disabled (*No. of Cases*)	Recovered (*No. of Cases*)	(*Per cent.*)
Without central dislocation	30	10	20	66.
With partial central dislocation	12	7	5	42.
With complete central dislocation	9	8	1	11.
Total	51	25	26	51.

it is trying for the patients. In only a few cases of this fracture will open reduction satisfactorily eliminate the intrapelvic protrusion of the femoral head. Even at operation, it is difficult and often impossible to loosen the impacted fragments and to gain correct reposition — a requirement which has to be fulfilled if the reduction of the femoral head is to be maintained. Many surgeons are therefore inclined to refrain from operative measures in the treatment of these fractures. They content themselves with treatment in extension and by traction in order to diminish the pressure of the femoral head against the acetabular fragments (possibly to improve the position of the latter) and to prevent further dislocation.

During the last five years, the author has treated about 180 cases of osteo-arthritis of the hip joint by means of the Smith-Petersen arthroplasty. During the treatment of a

FIG. 6-A

FIG. 6-B

Figs. 6-A and 6-B: Case 6. A woman, sixty-five years old, as the result of an accident, had sustained a severe pelvic fracture with complete central dislocation of the femoral head (Fig. 6-A, retouched). As an attempted closed reduction by means of lateral traction with two screws inserted into the greater trochanter had failed (one of the screws broke), the patient was subjected to operation on July 14, 1953. The reduction of the pelvic fracture was successful. After the removal of some loose fragments, the acetabulum was reshaped. The femoral head was covered with a large Vitallium mold which fitted the acetabulum well and which gave to the femoral head an almost normal position within the acetabulum (Fig. 6-B).

The patient left the Hospital on December 7, 1953. At that time she had recovered practically normal motion in the joint. She was able to walk without any support and had good stability and no pain in the hip.

severe central dislocation of the femoral head, the author thought that it might be possible to prevent the development of osteo-arthritis and to obtain a better prognosis through the use of a Vitallium cup in the joint. Up to 1953, the author had performed this arthroplasty in the treatment of six central dislocations of the femoral head.

TECHNIQUE

Through an anterior incision the joint is opened, and the femoral head is dislocated anteriorly, which sometimes (especially in complete central dislocations) can be difficult. An attempt is then made to reconstruct the hip joint through the repositioning of the acetabular fragments as accurately as possible in order to give the femoral head a normal position. This repositioning is very difficult. In one patient the reduction was almost complete and in the others reduction was only more or less successful. All projecting bone ends are resected and the acetabulum is made to conform to the surface of the Vitallium mold. After this has been done, hematoma, capsular fragments, and lacerated muscle tissue are removed. The femoral head is covered with the mold and is repositioned. The mold must not only be large enough to gain support from the acetabular margin but also must be large enough to keep from pressing the acetabular fragments toward the interior of the pelvis. In this way the mold will prevent the femoral head from sinking deep into the pelvis. Lateral displacement of the femoral head will facilitate motion, especially rotation and abduction. It was thought that, if the acetabular surface were made smooth and the fracture lines in contact with the head in the mold were covered, the tendency to excessive bone formation and the development of marginal excrescences might be considerably diminished.

The results in the treatment of central dislocation of the femoral head by mold arthroplasty in at least five of the six patients have been encouraging. As a search of the literature failed to reveal any reports of acetabular fractures with central dislocation of the femoral head treated by means of arthroplasty, it was thought that a brief account of the author's experience with six cases might be of interest. In the four patients in whom the treatment has been completed, movement at the hip joint is practically normal and is without pain; the joint is stable; the limp is insignificant; and walking gives little trouble.

The interval between operation and the follow-up examination of these patients was three years, two years, fifteen months, fourteen months, and six months, respectively. Four of the patients have returned to their regular work; three of them are working in a factory. One patient (Case 5) is still under treatment (physical therapy) in her home and is not yet capable of working.

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FRACTURE-DISLOCATION OF THE HIP

An End-Result Study *

BY MARCUS J. STEWART, M.D., AND LEE W. MILFORD, M.D., MEMPHIS, TENNESSEE

Traumatic dislocation of the hip by excessive force is a severe injury which often produces a multiplicity of immediate and late complications and presents a major therapeutic problem. The present analysis deals with the treatment of this injury, the complications, and the end results in patients who have been observed at the Campbell Clinic during the past thirty years. Of a total of 193 patients treated, an adequate follow-up of 128 has been possible; these form the basis of our study.

Armstrong analyzed 101 traumatic dislocations of the hip in patients treated in the orthopaedic centers of the Royal Air Force. Although his conclusions were interesting and instructive, they were based upon short-term observations; follow-up was done primarily by correspondence. Urist's reports [16, 17, 18] on three groups of patients treated in military service are also interesting and enlightening, although a longer and more detailed follow-up would have been desirable. A review of the literature reveals many other reports of the results of treatment of traumatic dislocations of the hip; the majority, however, are based upon small series of cases with short periods of follow-up. A notable exception is the excellent report of Thompson and Epstein, upon which the authors have drawn extensively in making this analysis.

Etiology

As the means of transportation are accelerated, we are confronted with an increasing number of dislocations of the hip,—previously a rare injury. Of our 193 cases, 139 (72 per cent.) were the result of automobile accidents. It has been observed that the driver of an automobile who sustains a posterior dislocation usually has a more severe injury than a passenger. As the brake is applied, the driver's hip is driven upward, and a posterior-superior dislocation is produced by the impact.

The passenger's hip is more often flexed at the moment of impact and is driven downward and backward, and less damage is sustained by the acetabulum.

Forty-one (21 per cent.) of the dislocations in the authors' series were produced by falls or falling objects. Other types of trauma were responsible for thirteen dislocations (7 per cent.) (Table I).

Age Incidence

As shown in Table II, 146 (75 per cent.) of these patients were between the ages of sixteen and fifty years. Seven were under fifteen. The youngest was four, and the oldest was seventy-six years of age.

Classification of Dislocations

If one were to attempt to classify dislocations of the hip according to all the possible types and grades, he would become lost in a maze of terms. In this study, the position of the dislocation is referred to as the *type*, and the severity of the fracture of the acetabulum or the femoral head as the *grade*. The study includes posterior, central, anterior, and obturator dislocations. The authors have observed no dislocations into the perineum. They agree with Key and Conwell who stated that central dislocations are, in reality, fractures of the pelvis; the symptoms, however, are chiefly those of a hip-joint injury, and the re-

* This paper was presented in part, with the co-authorship of Dr. James S. Speed, at the Joint Meeting of the Orthopaedic Associations of the English-Speaking World, London, June 30, 1952.

TABLE I

CAUSES OF DISLOCATION

Etiology		No. of Cases	Per cent.
Automobile accidents		139	72
Falls or falling objects		41	21
Other		13	7
Motorcycles	3		
Tractors	3		
Bicycle	1		
Railroad cars	3		
Airplane	1		
Wagon (horse)	1		
Wrestling	1		
Total		193	100

sulting disability affects the hip. The authors have, therefore, elected to analyze and to compare central dislocations with other types of dislocation:

Grade I: simple dislocation without fracture or with a chip from the acetabulum so small as to be of no consequence;

Grade II: dislocation with one or more large rim fragments, but with sufficient socket remaining to ensure stability after reduction;

Grade III: explosive or blast fracture with disintegration of the rim of the acetabulum, which produces gross instability;

Grade IV: dislocation with a fracture of the head or neck of the femur.

This grading applies to all types of dislocation except central dislocations which were classified as follows:

Grade I Central: linear or stellate fracture through the floor of the acetabulum but without appreciable dislocation;

Grade II Central: comminuted fracture with a mild to moderate central displacement of the femoral head and of the acetabular fragments;

Grade III Central: marked displacement of the fragments and protrusion of the head of the femur into the pelvis, with or without comminution of the superior portion of the acetabulum;

Grade IV Central: dislocation with an associated fracture of the head or neck of the femur.

Cases for Final Analysis

For this study the authors have reviewed 193 patients with traumatic dislocation of the hip observed at the Campbell Clinic. There were 194 dislocations, one patient having had a bilateral injury. Of these, 142 (74 per cent.) were of the posterior type. The right

TABLE II

AGE AT TIME OF INJURY

Age (*Years*)	No. of Cases	Per cent.
0–15	7	4
16–30	58	30
31–40	45	23
41–50	43	22
51–60	25	13
61 or over	15	8
Total	193	100

TABLE III

193 CASES OF TRAUMATIC DISLOCATION (194 HIPS)

Types of Dislocation	Surgical	Non-Surgical	Total	Per cent.*
Posterior	38	104	142	74
Anterior	1	5	6	3
Obturator	1	7	8	4
Central	5	23	28	14
Unknown		10	10	5
Total	45	149	194	100
Sex—193 Patients				
Male	39	109	148	77
Female	6	39	45	23
Total	45	148	193	100
Laterality—194 Hips				
Right	19	75	94	49
Left	26	74	100	51
Total	45	149	194	100

* Percentages are calculated and recorded to the nearest whole number.

hip was affected in ninety-four and the left in 100. This injury, being the result of excessive or vigorous trauma, is more often associated with the occupations and activities of men; thus it is not surprising that the incidence was three times as high in men as in women (Table III).

In the end-result study, only those patients were included who could be followed for one or more years. This excluded sixty-five of the 193 patients. Of the remaining 128 patients, ninety-five had been treated by closed or manipulative reduction and thirty-three by surgery. Five died following manipulative reduction, leaving a total of 123 for study. Seventeen of these were followed for one to two years, fifty-six for two to ten years, and fifty for ten years or longer (eleven of these were followed for twenty years or more) (Table IV).

A number of the patients were not followed during intervals varying from a few to

TABLE IV

FOLLOW-UP PERIOD FOR SERIES

Follow-up	Non-Surgical	Surgical	Total No. of Cases
1 year	15	2	17
2 years or over	9	5	14
3 years or over	14	7	21
5 years or over	12	9	21
10 years or over	15	6	21
15 years or over	16	2	18
20 years or over	9	2	11
	90	33	123
Deaths			5
Total			128

many years, and thus the records of their progress in these intervals are missing from the study. It is probable, however, that a more complete follow-up would have had little influence upon the final evaluation.

Follow-up examination was done by the authors on seventy patients, by other members of the Campbell Clinic staff on forty-four, by other physicians on six, and through questionnaires on three. Many other questionnaires were answered, but the information and roentgenograms were not adequate for the end-result study. For the six patients followed by other physicians, roentgenograms, answered questionnaires, and reports of examinations which had been completed according to instructions were received.

Criteria for Classification of Results

In classifying the results, the authors have combined clinical and roentgenographic findings for a study of the case as a whole.

The result was regarded as *excellent* if the hip had returned to normal with a full, free range of motion, if the patient had no pain, weakness, or fatigue, and if the roentgenograms revealed no narrowing of the joint space, vascular changes, or arthritis.

The result was considered *good* if the patient had no appreciable pain or limp, except after a long day of hard work and weight-bearing, and not more than a 25 per cent. restriction of motion without interference with daily activity. The roentgenograms might show minimal arthritic changes but no evidence of avascular necrosis or narrowing of the joint space.

A *fair* result was characterized by mild to moderate pain, a slight limp, and restriction of motion of 25 to 50 per cent. The patient's capacity for work, although curtailed, was still adequate for a sustaining occupation. Moderate arthritic changes and the formation of osteophytes, with mild to moderate narrowing of the joint space, was demonstrated in the roentgenograms.

Patients with *poor* results had pain, limp, moderate to extreme limitation of motion, and were unable to engage in an occupation which required walking or standing. Roentgenograms revealed one or more of the following: advanced arthritis, avascular necrosis of the head of the femur, pronounced narrowing of the joint space and cyst formation, and sclerosis of the acetabulum.

RESULTS FOLLOWING CLOSED REDUCTION

In Table V is presented a summary of the types of dislocation, the grades of fracture, and the results in the ninety patients treated by non-surgical methods.

Of these ninety patients, sixty-nine had posterior dislocation. In thirty-six excellent or good results were obtained, and in thirty-three fair or poor results were obtained.

In the patients with posterior dislocation, Grade I, the results were excellent or good in nineteen of twenty-five patients; in those with posterior dislocation, Grade II, the results were excellent or good in fourteen of thirty-three patients; and in those with posterior dislocation, Grade III, the results were excellent or good in two of nine patients In the two patients with posterior dislocation, Grade IV, an excellent result was obtained in one patient, and a poor result was obtained in the other. Both of the dislocations, Grade IV, were associated with a fracture of one third to one half of the head of the femur. The excellent result was obtained in a woman, twenty-one years old, but she has been followed for only one year,—insufficient time to permit final evaluation. The poor result was obtained in a woman, sixty-four years old, who was not transferred to the Clinic until three days after injury. Her dislocation was reduced and traction was maintained for six weeks. Nine months after the reduction, avascular necrosis was apparent; twelve months after reduction, frank infarction and degeneration had developed. Eleven and a half years after the injury, the result was still rated poor. The patient was ambulatory, with moderate to severe pain and a slight limp. The surprising feature of this case was that the patient

TABLE V

RESULTS EVALUATED BY TYPE AND GRADE

Type	Grade	Excellent		Good	Fair		Poor	Total
Posterior	I	13		6	2		4	25
	II	7		7	9		10	33
	III	2			2		5	9
	IV	1					1	2
Total		23	+	13 = 36	13	+	20 = 33	69
Central	I			3			1	4
	II	1		4			2	7
	III	1			1		5	7
	IV							
Total		2	+	7 = 9	1	+	8 = 9	18
Anterior	I	1						1
Obturator	I	2						2
Grand Total		28	+	20 = 48	14	+	28 = 42	90

had practically normal flexion, abduction of 25 per cent., adduction of 75 per cent., and internal and external rotation of 20 per cent.

One patient had an anterior dislocation, Grade I, and two patients had obturator dislocation, Grade I. They were treated by immediate closed reduction with excellent results.

Eighteen patients with acetabular fractures (with or without central dislocation) were treated by closed manipulation; in nine of these excellent or good results were obtained, and in nine, fair or poor results were obtained. The results were excellent or good in three

TABLE VI

RESULTS IN PRIMARY SURGICAL CASES

Type	Grade	Excellent	Good	Fair	Poor	Total
Posterior	I	1	1		5[a]	7
	II	2	2[b]	3	1	8
	III		2[c]	1	4	7
	IV			1[d]	4	5
Total		3	5	5	14	27
Central	I					
	II					
	III			1	2	3
	IV		1			1
Total			1	1	2	4
Anterior	I		1			1
Obturator	I				1	1
Grand Total		3	7	6	17	33

[a] One patient had a primary arthroplasty.
[b] Two patients had primary arthrodeses.
[c] One patient had a primary arthrodesis.
[d] One patient had a primary Whitman reconstruction.

TABLE VII

RESULTS CORRELATED WITH THE TIME THE DISLOCATION WAS UNREDUCED IN NINETY CASES OF CLOSED MANIPULATION

Grade	0–12 Hours		13–24 Hours		25–48 Hours		49 Hours or more		Total
	Excellent or Good	Fair or Poor	Excellent or Good	Fair or Poor	Excellent or Good	Fair or Poor	Excellent or Good	Fair or Poor	
Posterior									
I	15		4			2		4	25
II	9	3	5	3		5		8	33
III	2							7	9
IV			1					1	2
Total	26	3	10	3	0	7	0	20	69
Central									
I	3	1							4
II	4		1					2	7
III	1	1		1				4	7
Total	8	2	1	1	0	0	0	6	18
Anterior	1								1
Obturator	2								2
Grand Total	37	5	11	4	0	7	0	26	90

Reduced in less than 24 hours:
Excellent or Good 48
Fair or Poor 9

Reduced after more than 24 hours:
Excellent or Good 0
Fair or Poor 33

of the four with fractures, Grade I (acetabular fractures alone), and in five of seven with fractures, Grade II. In the seven patients with fractures, Grade III, only one showed an excellent or good result; in the remaining six patients, a fair result was obtained in one and poor results were obtained in five. None of the patients had a dislocation, Grade IV Central.

RESULTS FOLLOWING SURGICAL TREATMENT

Table VI gives the results in the thirty-three patients treated surgically, according to the types and grades of the dislocation.

Five of these patients had a reconstructive procedure as the first operation. One had a posterior dislocation, Grade I, which had been unreduced for thirteen months; a Vitallium-cup arthroplasty was done, but the result was poor. Two patients with posterior dislocation, Grade II, had primary arthrodesis within forty-eight hours after injury; in both the results were good. In the fourth patient, a posterior dislocation, Grade III, was unreduced for seventy-two hours; arthrodesis brought about a good result. The fifth patient, who had had a posterior dislocation, Grade IV, was operated upon two weeks after injury; a Whitman reconstruction was performed with a fair result.

The remaining twenty-eight patients were treated by open reduction. Of these, twenty-two patients had had posterior dislocation, four had had central dislocation, one had had anterior dislocation, and one had had obturator dislocation. In seven the results were excellent or good, while in twenty-one (three times as many) the results were fair or poor.

INFLUENCE OF TIME OF REDUCTION ON END RESULTS

The patients treated by non-surgical methods and those treated surgically were studied with respect to the time of reduction (the period between the hour of the accident and the time of reduction).

Patients Treated by Non-Surgical Methods

In Table VII the results are correlated with the time of reduction in the ninety patients treated by non-surgical methods, the five fatalities having been excluded. The patients have been divided into groups: those treated within the first twelve hours, those treated within the second twelve hours, those treated within the second twenty-four hours, and those treated after forty-eight hours.

Twenty-nine of the patients with posterior dislocation, Grade I, II, or III, had the dislocation reduced within the first twelve hours. In twenty-six of these, excellent or good results were obtained, while in the remaining three, all with posterior dislocation, Grade II, fair or poor results were obtained.

Thirteen patients with posterior dislocation, Grade I, II, or IV, were treated by closed reduction within thirteen to twenty-four hours after injury. In ten of these the results were excellent or good, and in three the results were fair or poor.

Seven patients with posterior dislocation, Grade I (two) and Grade II (five), were treated by closed reduction within twenty-five to forty-eight hours; all showed fair or poor results.

Twenty patients with posterior dislocation, all grades, were treated by closed reduction after forty-eight hours; in no patient was an excellent or good result obtained.

The one anterior dislocation, Grade I, and the two obturator dislocations, Grade II, were reduced within twelve hours, and excellent results were obtained.

Of the eighteen patients with central dislocation and fracture, ten were treated by closed reduction within the first twelve hours; eight of these showed excellent or good results, and two showed fair or poor results. Four patients had had dislocation, Grade I Central; in three of these excellent or good results were obtained, and the fourth showed a

TABLE VIII

RESULTS CORRELATED WITH THE TIME THE DISLOCATION WAS UNREDUCED IN THIRTY-THREE SURGICAL CASES

Grade	0–2 Days		2–4 Days		4–7 Days		7–14 Days		14–30 Days		30–120 Days		120–180 Days		180 Days or More	
	Excellent or Good	Fair or Poor	Excellent or Good	Fair or Poor	Excellent or Good	Fair or Poor	Excellent or Good	Fair or Poor	Excellent or Good	Fair or Poor	Excellent or Good	Fair or Poor	Excellent or Good	Fair or Poor	Excellent or Good	Fair or Poor
Posterior																
I	1															
II	3			1		1		1	1					1		3
III	1							1	1					1		
IV				1				1	1	1		2				1
								1		1		2				
Total	5	0	0	2	0	1	0	4	3	2	0	4	0	2	0	4
Central																
I																
II																
III				1												
IV							1			1		1				
Total	0	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0
Anterior											1					
Obturator								1								
Grand Total	5	0	0	3	0	1	1	5	3	3	1	5	0	2	0	4

fair or poor result incidental to avascular necrosis. In four patients with dislocation, Grade II Central, excellent or good results were obtained. In two patients with dislocation, Grade III Central, the result was excellent or good in one and fair or poor in the other.

Two patients with central dislocation were treated by closed reduction within thirteen to twenty-four hours after injury. The patient with dislocation, Grade II Central, showed an excellent result; the patient with dislocation, Grade III Central, showed a poor result.

In none of the patients with central dislocation was reduction accomplished in the period twenty-five to forty-eight hours after injury.

Two patients with dislocation, Grade II Central, and four with dislocation, Grade III Central, were treated after forty-eight hours had elapsed from the time of injury; both patients showed poor results.

From a critical review of the central dislocations, it appears that the severity of the trauma and the damage sustained by the acetabulum have a more profound effect upon the end result than the length of time the hip remains unreduced. Avascular necrosis developed in five of the eighteen patients. Obviously, some factor other than injury to the vessels of the capsule and femoral neck is responsible for this complication. This factor will be discussed later in this paper.

Of the forty patients who were treated by closed manipulation within the first twelve hours after injury, thirty-six showed excellent or good results and five showed fair or poor results. Of the fifteen who were treated within the second twelve hours, eleven showed excellent or good results, and four showed fair or poor results. Thirty-three patients were treated after twenty-four hours; fair or poor results were obtained in all, regardless of the type or grade of dislocation.

It is a rather startling fact that in this series no patient in whom reduction was delayed beyond twenty-four hours showed a good result. If a good result is to be expected, dislocations, especially posterior dislocations, must be reduced as soon as possible after the injury. There is a common misconception that a patient who is suffering from severe injury and shock is in too critical a condition for the administration of anaesthesia. A short-acting anaesthesia is not contra-indicated if the patient's air passages are open and if reduction can be accomplished within a few minutes. Moreover, the reduction of a dislocated hip always tends to relieve shock and is often the key to recovery.

Patients Treated Surgically

In Table VIII are shown the results of thirty-three surgical reductions, which are correlated with the time between injury and operation.

Of five patients with posterior dislocation, four were operated upon within the first twenty-four hours after injury, and one was operated upon in the second twenty-four hours after injury. In three the results were good, and in two the results were excellent. Two of these cases are exceptionally interesting. One patient had a posterior dislocation, Grade II (Fig. 1), and the other a posterior dislocation, Grade III (Fig. 2). Both patients had received multiple severe injuries of the head, chest, and pelvis. Each had an immediate manipulative reduction and each was placed in skeletal traction,—the first patient after six hours and the second after four hours. Surgery was delayed because of their poor general condition. After seven and eight days, respectively, the rim fragments were repositioned and were fixed with stainless-steel screws through a posterior approach. Multiple small fragments and all free chips of bone were removed. The first patient was followed for three and a half years and the second for three years; both showed good functional results.

In the four patients who were operated upon within one week after the injury, fair results were obtained in two and poor results were obtained in two. One patient who had had an unusual posterior dislocation, Grade IV, showed a poor result (Fig. 3). This patient had a Vitallium-cup arthroplasty performed twenty-four months after the reduction.

Twelve patients were operated upon within one week to one month after the dislocation; in four the results were excellent or good, and in eight the results were fair or poor. This group included one patient who had had an obturator dislocation and who showed a poor result.

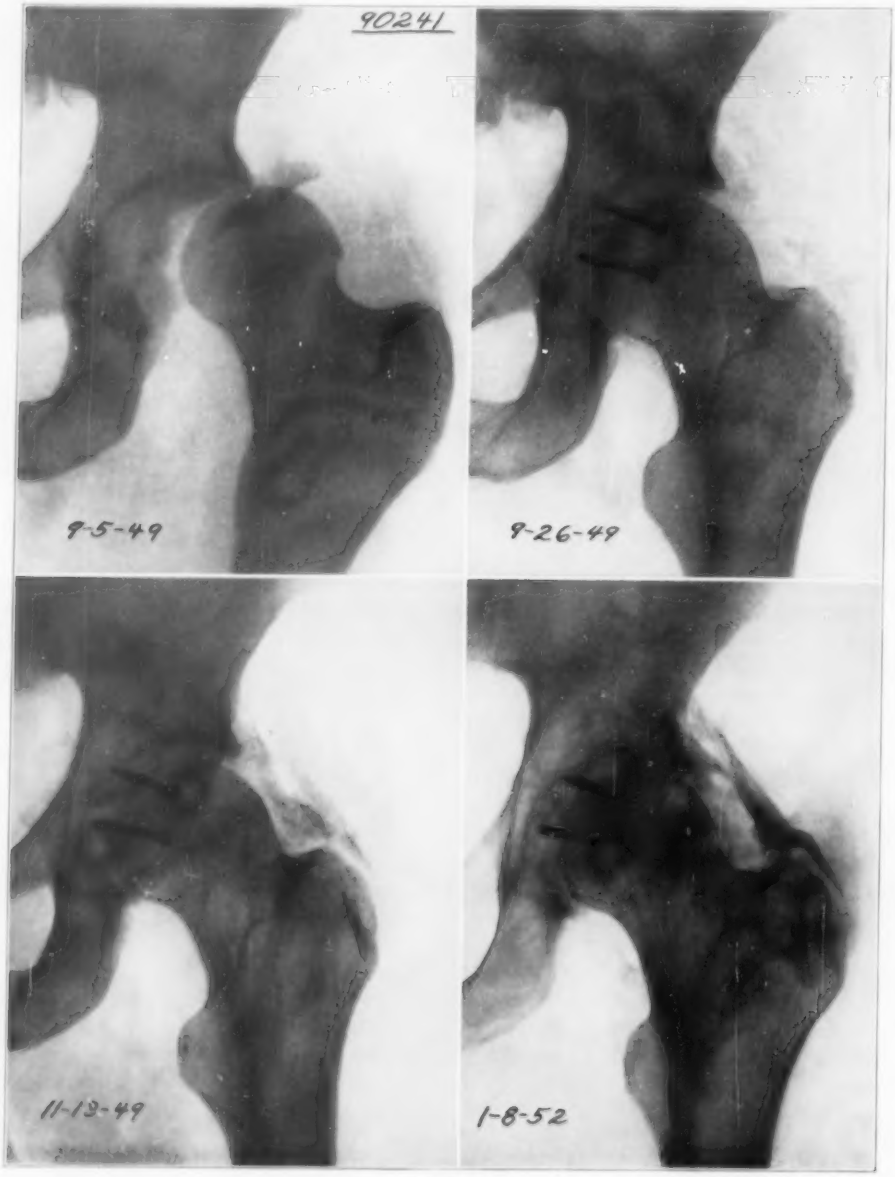

FIG. 1

First roentgenogram shows a posterior dislocation, Grade II. Closed reduction was done six hours after injury and a Hodgen splint was applied. Operation was performed seven days after the accident. Walking with crutches was begun at two months, and full weight-bearing was allowed at eight months. Myositis ossificans was apparent at three weeks; arthritis was seen at two months; and avascular necrosis was seen in the roentgenograms at twenty-two months. In this patient, there was a good functional result three and a half years after reduction.

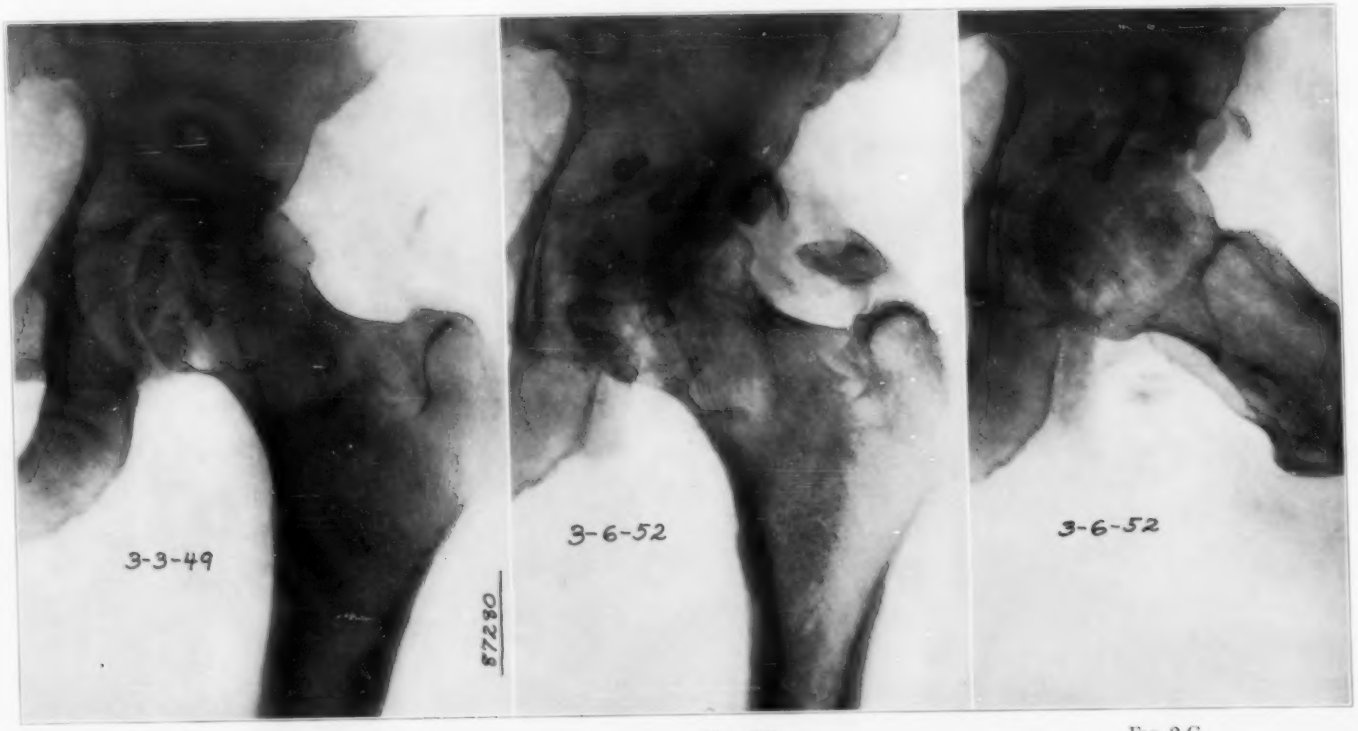

FIG. 2-A

FIG. 2-B

FIG. 2-C

This patient had a posterior dislocation, Grade III, which was reduced by skeletal traction four hours after the accident. Operation was performed on the eighth day, and traction was maintained for three weeks postoperatively. Weight-bearing with crutches was allowed two months postoperatively, and full weight-bearing was permitted three months postoperatively. Myositis ossificans was apparent four weeks after the operation. Three years postoperatively, the patient had a full range of motion without pain or limp.

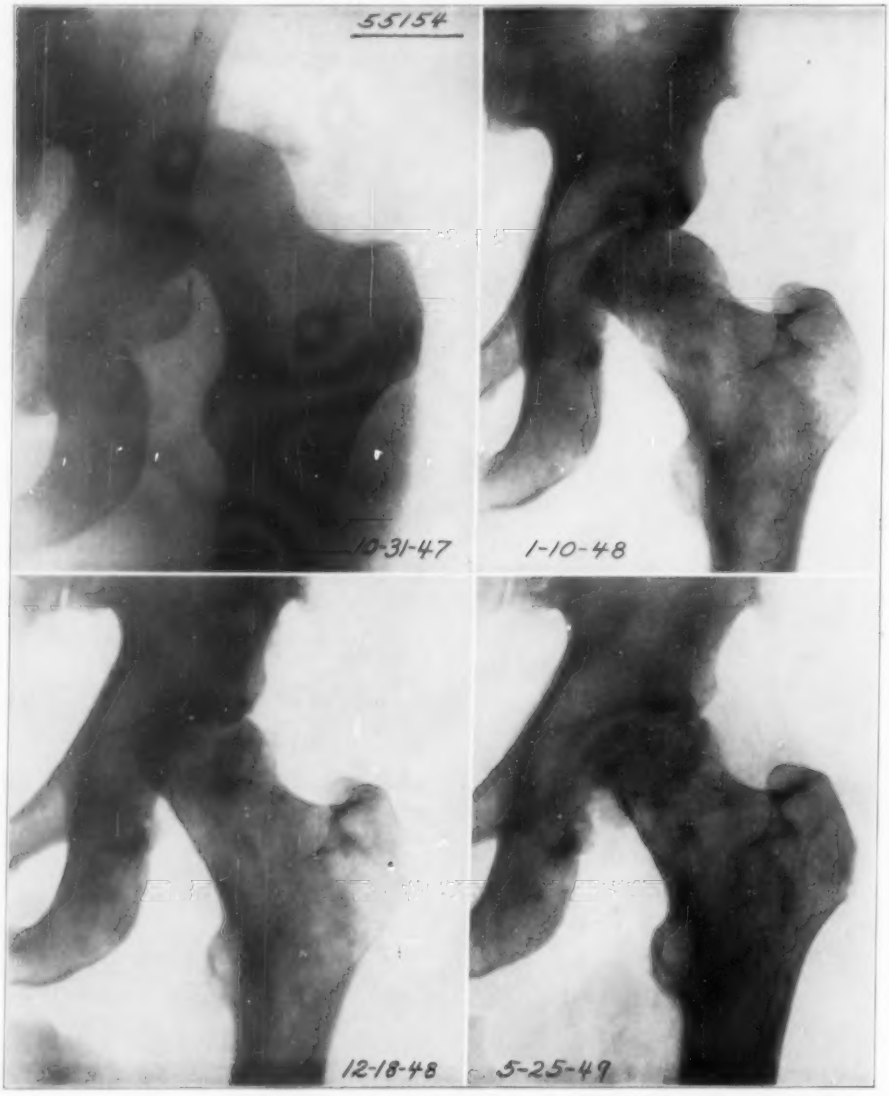

FIG. 3

First roentgenogram shows a posterior dislocation, Grade IV, with fracture of the inferior portion of the femoral head, which was reduced three days after the accident. Avascular necrosis developed twelve months after reduction, and twenty-three months after reduction a pathological fracture occurred. Vitallium-cup arthroplasty was performed two years after reduction. Three years after the arthroplasty, there was a good result.

Twelve patients were operated upon one month or more after injury. In one a good result was obtained, and in eleven fair or poor results were obtained.

The patient who showed a good result was a man, twenty-one years old, who had had an anterior dislocation. He was operated upon four months after the accident. Reduction was accomplished through a Smith-Petersen incision,—the approach used in 75 per cent. of our patients. After immobilization in a double spica for two months, he was allowed partial weight-bearing with crutches; at five months he was permitted full weight-bearing. The

TABLE IX

RESULTS CORRELATED WITH THE AGE OF THE PATIENT AND TYPE OF DISLOCATION

Age	Posterior, Anterior, and Obturator				Central				Total			
	Non-Surgical		Surgical		Non-Surgical		Surgical		Non-Surgical		Surgical	
	Excellent or Good	Fair or Poor	Excellent or Good	Fair or Poor	Excellent or Good	Fair or Poor	Excellent or Good	Fair or Poor	Excellent or Good	Fair or Poor	Excellent or Good	Fair or Poor
0–15	2			1					2			1
16–30	11	11	3	6	3		1	2	14	11	4	8
31–40	7	8	4	8	2	2		1	9	10	4	9
41–50	10	9	1		2	5			12	14	1	
51–60	6	4	2	1	1	1			7	5	2	1
61 or over	3	1		3	1	1			4	2		3
Total	39	33	10	19	9	9	1	3	48	42	11	22

authors are fortunate in having been able to observe this patient over a period of twenty-three years. The patient is now employed as a foreman in a coal mine.

INFLUENCE OF AGE UPON END RESULTS

Regardless of the type or grade of the dislocation or of the method of treatment (non-surgical or surgical), the ratio of excellent or good results to fair or poor results was approximately the same for patients of various ages in this series. In patients treated by non-surgical methods, forty-eight showed excellent or good results and forty-two showed fair or poor results; among the patients treated surgically, there were excellent or good results in eleven and fair or poor results in twenty-two (Table IX).

In the group of patients treated by non-surgical methods, there were two patients who were fifteen years old or less; both showed excellent results. In twenty-five patients between sixteen and thirty years old, excellent or good results were obtained in fourteen and fair or poor results were obtained in eleven. Nineteen patients were between thirty-one and forty years old; in nine of these the results were excellent or good, and in ten the results were fair or poor. Of twenty-six patients between forty-one and fifty years old, twelve showed excellent or good results and fourteen showed fair or poor results. Of twelve patients between fifty-one and sixty years old, seven showed excellent results and five showed fair or poor results. Six patients were over the age of sixty-one; in four the results were excellent or good, and in two the results were fair or poor. A similar situation was found in the group of patients who were treated surgically.

These numbers, although small, suggest that the results following reduction of dislocation of the hip are not materially affected by the ages of the patients.

INFLUENCE OF EARLY ACTIVE EXERCISE ON END RESULTS

As pointed out by Luck and others, early active exercise after injury to joints helps to prevent traumatic arthrofibrosis of the articular surfaces and to restore function in adjacent muscles. It was observed repeatedly in our patients that the more vigorous the remedial exercises during the convalescent stage, the better the end result, since motion was maintained in the planes of activity. This was true in patients treated surgically, as well as in patients who were treated by non-surgical methods, even after dislocation associated with a severely fractured acetabulum. Several patients with posterior dislocation, Grade III, were treated successfully by skeletal traction, after manipulative reduction, for six to eight weeks; the maintenance of reduction was confirmed at frequent intervals by bedside roentgenograms. Early active exercise of the various muscle groups with as much motion as could be executed while the limb was in balanced traction was encouraged. An

FIG. 4-A FIG. 4-B

Mrs. E. B., aged seventy-six, had a posterior dislocation, Grade III, which was reduced six hours after injury. Traction was applied and was maintained for four weeks; bed exercises were carried out during the period of traction. After the period of traction, a plaster cast was applied and was worn for four weeks. Partial weight-bearing was permitted ten weeks after injury and full weight-bearing was allowed at three months. Excellent results were seen in this patient three years after reduction; minimal arthritis was apparent, but there was no avascular necrosis.

FIG. 5-A

FIG. 5-B

This patient had a dislocation, Grade III Central, which was reduced by skeletal traction three hours after injury. Traction was maintained for one month. Full weight-bearing was allowed four months after reduction. Vigorous occupational therapy which caused activity of the hip was carried out. Twenty-four years after the accident the result was excellent.

illustrative case is that of a woman, seventy-six years old, who had an immediate closed reduction followed by traction and mobilization. Active exercise was carried out during the period of traction, partial weight-bearing was allowed at ten weeks, and full weight-bearing was permitted at three months. At the end of three years, her result was still rated excellent (Figs. 4-A and 4-B).

In a considerable number of patients, the results were much better than those which appeared possible from the initial or final roentgenograms. A patient with dislocation, Grade III Central, was treated by closed reduction and traction for one month. Weight-bearing with crutches was allowed at two months, and full weight-bearing was permitted at four months. He returned to work as a surveyor, and his duties involved a walk of several miles every day. At the end of a year, he was walking fifteen to twenty miles daily. Initially, for eight or nine months, he had suffered rather severe pain; but thereafter he was entirely free from pain. During World War II, he served three years at full military duty without experiencing any disability or discomfort in the hip. This patient has been followed for twenty-four years, and the result is excellent (Figs. 5-A and 5-B). The patient states, and wisely, that he believes the relatively early and vigorous active exercise of the hip was responsible for the successful outcome.

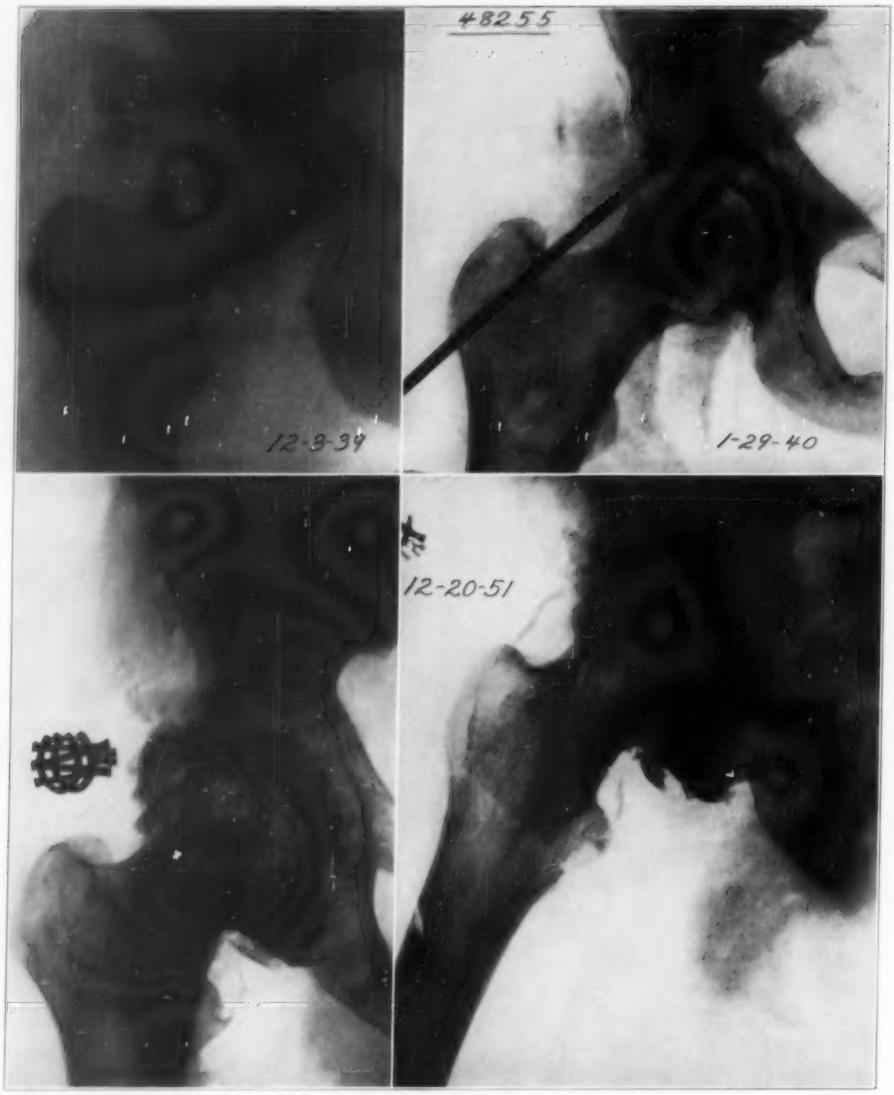

FIG. 6

First roentgenogram shows a posterior dislocation, Grade III. Open reduction was performed through a Smith-Petersen incision, with stabilization achieved by means of a Steinmann pin driven through the trochanter into the pelvis. The patient was immobilized in plaster for three months. Crutch-walking was allowed at four months, and full weight-bearing was permitted at twelve months. Advanced arthritis was apparent on roentgenograms made twelve months after operation; there was no avascular necrosis. Thirteen years after the operation, there was a good functional result; the result was much better than that indicated by the roentgenograms.

Figure 6 illustrates a case in which the clinical result was much better than that indicated by the final roentgenogram. The patient had a posterior dislocation, Grade III. Although the roentgenogram, which was made thirteen years after reduction, shows advanced arthritis, a good functional result was obtained. Obviously, the prognosis is better in a stoical person than in a person with a low threshold for pain.

Many patients who were treated by closed manipulation improved with time, and

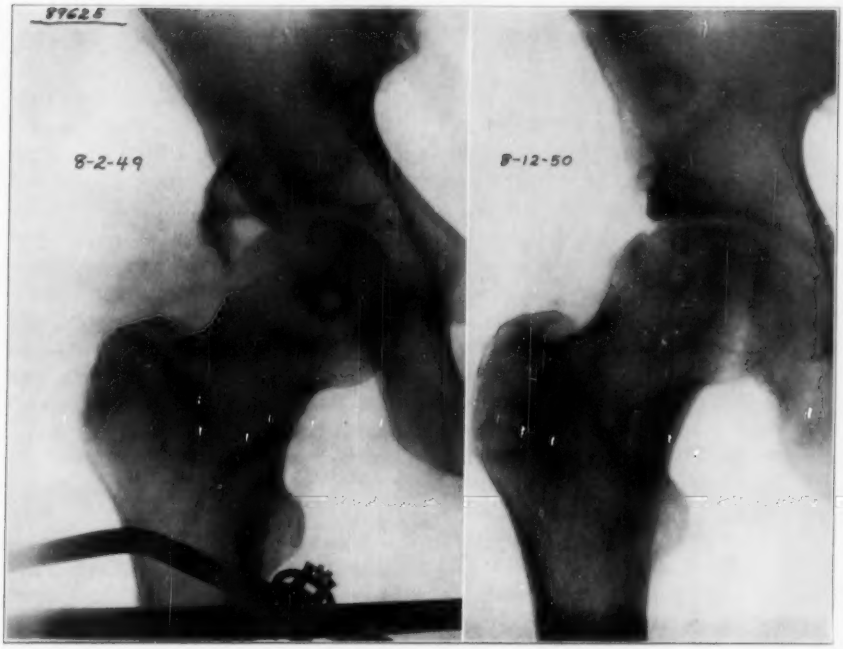

FIG. 7-A FIG. 7-B

A posterior dislocation, Grade II, is shown. This was reduced twenty-four hours after the accident. Bed rest for five weeks was followed by partial weight-bearing. Full weight-bearing was permitted eight weeks after the reduction. Five months after reduction there was pain in the hip; twelve months after reduction avascular necrosis was apparent. Arthroplasty was done at fourteen months with an excellent result being seen eighteen months later.

their range of motion increased during several years of activity. Of those treated surgically, however, the reverse was true. This fact becomes apparent upon comparison of the results in the fifty-two patients who were followed from one to five years with the results in the seventy-one patients who were followed five years or more. Of those who were treated by closed manipulation, only 50 per cent. showed excellent or good results before five years had passed, but after five years 66.6 per cent. showed excellent or good results. In contrast, in 66.6 per cent. of the patients who were operated upon, excellent or good results were obtained during the first five years; thereafter, however, excellent or good results were seen in only 38.5 per cent.

The authors believe that this improvement in patients treated by closed reduction is attributable in part to the "ironing-out" of the acetabulum or the development of a pseudo-arthroplasty. This is especially true in patients with central dislocation; it appears that a pseudo-arthroplasty develops, and a wider range of motion is obtained in the planes of motion demanded in the daily activities of these patients. A major factor in improvement seems to be an increase in strength and function of the muscles controlling the joint.

The decline in function of the hip in the patients treated surgically is explained largely by the fact that in them there was a much higher incidence of avascular necrosis and advanced arthritis. There is little doubt that initially these patients had sustained more severe trauma with greater damage to the acetabulum and adjacent soft tissues.

AVASCULAR NECROSIS

According to our concept, avascular necrosis is manifested by a definite demarcation in a portion of the head of the femur, suggesting infarction and an impending pathological

TABLE X

INCIDENCE OF AVASCULAR NECROSIS

	Non-Surgical = 14 Cases of 90 (15.5%)							Surgical = 11 Cases of 28 (40%)							
Type	Grade	Total	Avascular Necrosis	Aver. Age	Unreduced	Onset	Follow-up	Result	Grade	Total	Avascular Necrosis	Aver. Age	Unreduced	Onset	Follow-up	Result
				Years	*Days*	*Mos.*	*Years*					*Years*	*Days*	*Mos.*	*Years*	
Posterior	I	25	3	34	5	22	7	Poor 3	I	6	2	32	20	?	4	Poor 1
	II	33	7	35	2	17	7	Poor 5	II	7	2	32	65	22	8	Poor 1
								Fair 2								Fair 1
	III	9							III	6	2	58	11	16	6	Good 1
																Fair 1
	IV	2	1	52	3	9	11	Poor 1	IV	3	3	45	61	9	6	Poor 3
		69	11							22	9					
Central	I	4	1	55		12	3	Poor 1	I							
	II	7	1	32		24	4	Poor 1	II							
	III	7	1	47	5	10	16	Poor 1	III	3	2	28	12	23	10	Poor 2
	IV								IV	1						
		18	3							4	2					
Anterior	I	1							I	1						
Obturator	I	2							I	1						
		90	14	38 Aver.	3 Aver.	17 Aver.	7 Aver.	Poor 12 Fair 2		28	11	40 Aver.	21 Aver.	17 Aver.	7 Aver.	Poor 7 Fair 3 Good 1

fracture (Figs. 7-A and 7-B). In this analysis, mere increased density or mottling of the head of the femur and narrowing of the joint space were not regarded as evidence of avascular necrosis, but of arthritis.

The incidence of avascular necrosis is shown in Table X. In fourteen (15.5 per cent.) of the ninety patients treated by closed reduction, avascular necrosis developed. Of those treated surgically, twenty-eight had primary open reductions; in eleven of these (40 per cent.) avascular necrosis developed. These figures are noteworthy in relation to the intervals between the time of injury and reduction, which averaged three days in the ninety patients treated by closed reduction, in contrast to an average of twenty-one days in the thirty-three patients treated by surgery.

The combined incidence of avascular necrosis in the two groups was 21.2 per cent. This is in agreement with the observation of Watson-Jones that avascular necrosis develops in 20 to 30 per cent. of dislocated hips. Bancroft and Murray recorded degenerative changes in 50 per cent. of hips following traumatic dislocations.

The authors' study revealed that in the patients treated by closed reduction in whom avascular necrosis developed, the average interval before its appearance was seventeen months. These patients were followed for an average of seven years. Their ages ranged from thirty-two to fifty-five years, the average being thirty-eight.

In the group of patients treated surgically, the average length of time before avascular necrosis appeared was seventeen months. The average follow-up was seven years. The ages of these patients ranged from twenty-eight to 58.5 years, the average being forty.

It appears that once avascular necrosis has developed, the average rate of degeneration is the same, regardless of the type of treatment. Armstrong, however, reported the case of a patient in whom avascular necrosis appeared five years after the dislocation.

The literature is filled with reports of experiments, studies of pathology, and clinical analyses made in an attempt to explain the cause of so-called avascular necrosis. It would appear that several factors may be contributory. There is little doubt that the major factor is interruption of the blood supply to the head of the femur. Stuck and Vaughan stated, "It is the interruption of the blood supply at the time of the accident that produces the frequent late disability after traumatic dislocation of the hip". The interruption may be caused by laceration and thrombosis of the vessels in the capsule, the retinaculum, the ligamentum teres, or the intramedullary vessels of the femoral neck. It may be that trauma produces thrombosis in the intra-osseous vessels of the Haversian system. If this is true, the phenomenon may be compared to caisson disease, wherein nitrogen bubbles are capable of blocking the circulation in the arterioles and capillaries of bone.

In the opinion of the authors, there is probably another important factor in the development of avascular necrosis,—namely, the shock or force and counterforce of the initial trauma. Such a force may produce a molecular change which may precipitate intracellular crystalization sufficient to lead to avascular death of the bone. It is common knowledge that metal which sustains a severe shock may undergo molecular changes or rearrangement of ions sufficient to alter its structure and strength. Hyatt and his associates have recently suggested that a comparable change may take place in the freezing of bone (although organic substance undergoes minimal biochemical damage in freeze-drying, bone which is stored undehydrated in a deep freezer undergoes undesirable degenerative changes). This may well be due to molecular disturbance. It is noteworthy that nine of the patients had posterior dislocation, Grade III, and avascular necrosis did not develop in any of these. On the other hand, avascular necrosis developed in five with central dislocation, one being a patient with a Grade I dislocation, in whom there should have been no tearing of the soft tissues or injury to the blood vessels of the capsule or retinaculum. The theory of intracellular molecular change lends itself to interesting speculation.

When surgical trauma and delayed reduction are added to the immediate vascular

injury, the high incidence of late complications after open reduction is not surprising. Fahey holds the view, with which the authors concur, that open reduction of the hip tends to jeopardize any remaining circulation which might be intact.

Prolonged displacement of the femoral head tends to stretch and "wring out" the vessels of the retinaculum and to produce further thrombosis and occlusion of the primary source of the blood supply to the femoral head. The influence of this factor upon the development of avascular necrosis has been a subject of wide interest among investigators for a number of years. In 1938, Funsten and his associates reported twenty cases with a follow-up of three years or more; they commented upon the high incidence of avascular necrosis after delayed reduction. They concluded, "The longer the hip stays out of place, the poorer are the prospects of obtaining a satisfactory result by operation". The authors' experience has been similar to theirs in this respect.

The authors have carefully studied the intervals before partial and full weight-bearing was begun in regard to their influence upon the end results. No evidence of adverse effects of early weight-bearing was found in patients with fractures which were stable following reduction. Others, however, have expressed the opinion that there is a relationship between the two. Phemister [12, 13] was consistently an advocate of prolonged non-weight-bearing to prevent avascular necrosis. In 1941, Banks made an excellent report on avascular necrosis resulting from traumatic dislocation of the hip; he included forty-two cases collected from the literature and nine of his own. He recommended that the hip be protected from weight-bearing for four to six months after any type of dislocation, and he stated that avascular necrosis of the femoral head may develop in any of these patients.

ARTHRITIC CHANGES

The authors have not included in the group of patients with arthritic changes those patients in whom minimal or mild arthritic changes developed.

Of the ninety patients treated by closed reduction, moderate to severe arthritis developed in forty-four (48.8 per cent.). In none of these was an excellent result obtained, —there were eight good results, ten fair results, and twenty-six poor results (Table XI). The average age was forty-one years, the average number of hours before reduction was forty-two, and the average period of follow-up was nine years. As would be expected, the majority of the forty-four patients with moderate or severe arthritis had Grade III or IV dislocations.

All of the twenty-five patients treated by closed reduction in whom avascular necrosis developed had arthritis. Thirty-nine patients who were treated by non-surgical methods had arthritis but did not have avascular necrosis. Figure 8 shows avascular necrosis and arthritis developing after closed reduction of a posterior dislocation, Grade II.

Arthritis developed in twenty patients (71.4 per cent.) of the twenty-eight treated by open reduction. The average age of these patients was 30.4 years, and the average period of follow-up was ten years. The average time the dislocation remained unreduced was thirty-three days. Of these twenty patients, none showed excellent results. As already mentioned, they had obviously suffered more severe initial injuries. The outstanding fact, however, is that arthritic changes developed in only 48.8 per cent. of the patients treated by non-surgical methods compared to 71.4 per cent. of those in whom surgical reduction was done. The average interval between the accident and reduction was forty-two hours in the first group of patients and thirty-three days in the second group of patients.

SCIATIC-NERVE INJURY

Table XII shows the results of sciatic-nerve injuries. Of the 128 patients included in this study, seventeen (13.3 per cent.) sustained an injury of the sciatic nerve. In ten patients, the peroneal portion of the nerve was involved; in five, the tibial portion was affected; and in one, both divisions of the nerve were damaged.

TABLE XI

INCIDENCE OF ARTHRITIS—MODERATE OR SEVERE

		Non-Surgical Cases = 44 of 90 (48.8%)						Surgical Cases = 20 of 28 (71.4%)					
Type	Grade	Total	Arthritis	Aver. Age	Unreduced	Follow-up	Result	Grade	Total	Arthritis	Aver. Age	Unreduced	Follow-up	Result
				Years	*Hours*	*Years*					*Years*	*Days*	*Years*	
Posterior	I	25	7	32	36	11	Poor 5 Good 2	I	6	4	30	18	5	Poor 2 Fair 1 Good 1
	II	33	20	40	48	9	Poor 10 Fair 8 Good 2	II	7	3	30	7	10	Fair 3
	III	9	5	37	336	3	Poor 4 Fair 1	III	6	5	43	61	6	Poor 2 Fair 1 Good 2
	IV	2	2	42	48	9	Fair 1 Good 1	IV	3	3	45	51	7	Poor 3
		69	34						22	15				
Central	I	4	2	46	?	7	Poor 1 Good 1	I						
	II	7	4	46	12	12	Poor 2 Good 2	II						
	III	7	4	46	48	9	Poor 4	III	3	3	32	53	12	Poor 2 Fair 1
	IV							IV	1					
		18	10						4	3				
									1	1	21	120	23	Good 1
Anterior	I	1							1	1	12	11	4	Poor 1
Obturator	I	2												
		90	44	41 Aver.	42 Aver.	9 Aver.	Poor 26 Fair 10 Good 8		28	20	30.4 Aver.	33 Aver.	10 Aver.	Poor 10 Fair 6 Good 4

TABLE XII

INCIDENCE OF SCIATIC-NERVE INJURY*—TYPE OF INJURY AND RESULT

Type	Grade	Sex	Age	Per cent. of Nerve Damage		Time Unreduced	Length of Follow-up	Result in Hip	Per cent. of Nerve Recovery
				Peroneal	*Tibial*		*Years*		
Non-Surgical Cases									
Posterior	I	M	25	100		2 days	3	Poor	50
	I	M	20		50	12 hours	15	Excellent	100
	II	M	23	75		20 hours	1	Good	0
	II	F	60	100		5 hours	1	Fair	25
	II	M	31	100		23 hours	10	Poor	50
	II	M	60	100		4 hours	1	Good	75
	II	F	19		25	11 hours	23	Excellent	0
	III	M	50	100		2 weeks	4	Poor	100
	III	M	27	100		4 days	4	Fair	75
Central	I	M	43	100		3 hours	9	Good	50
	I	M	33		100	24 hours	16	Good	50
	III	F	47	75		5 days	16	Poor	50
Surgical Cases									
Posterior	I	F	17		50	6 mos.	2	Ankylosis	?
	II	M	27		100	4 days	16	Fair	0
	III	M	27	100	75	3 weeks	4	Poor	?
	III	M	31	100		6 weeks	13	Good	50
	IV	M	31		?	3 days	5	Good	100

* Of 128 patients, seventeen (13.3 per cent.) sustained sciatic-nerve injuries.

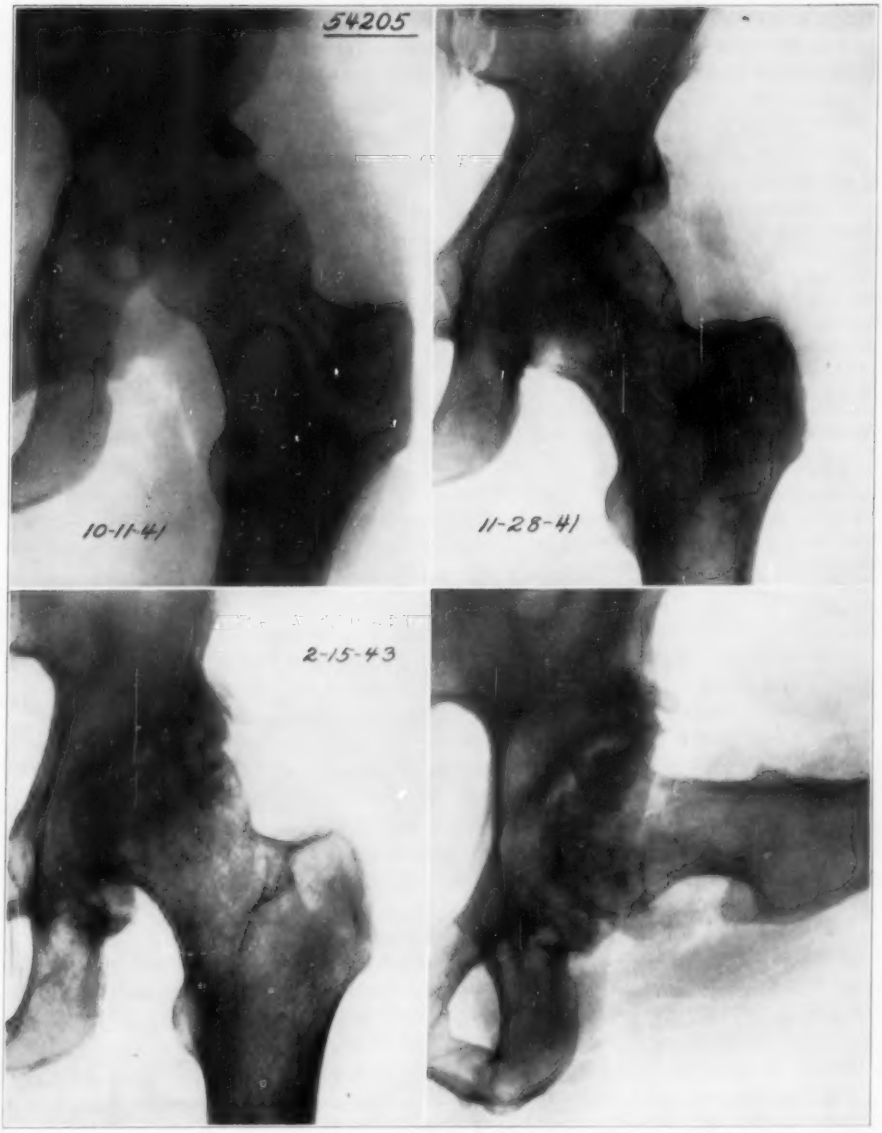

FIG. 8

A posterior dislocation, Grade II, was reduced forty-eight hours after injury. A plaster cast was worn by the patient for five weeks; at that time roentgenograms showed excellent reduction. Pain in the hip began eight months after reduction, and avascular necrosis was apparent at sixteen months, with associated arthritis. Two and a half years later, this patient showed a fair result.

After reviewing these cases in respect to etiology, type and grade of dislocation, age of the patient, time before reduction, and the number of years of follow-up, the authors have been unable to establish any relationship between nerve injury and recovery of the hip. Thompson and Epstein, on the contrary, observed possible signs of such a relationship. In this series, the authors have found excellent results in the hip in patients who had complete recovery of the sciatic nerve and in others with no nerve recovery, as well as

TABLE XIII

SECONDARY RECONSTRUCTIVE SURGERY FOLLOWING OLD DISLOCATION OF THE HIP

Procedure	Type	Grade	Age	Time after Surgery	Length of Follow-up	Result
				Months	*Years*	
Arthroplasty (cup)	Posterior	I	27	13	5	Fair
Arthroplasty (cup)	Posterior	I	34	36	14	Good
Arthroplasty (cup)	Posterior	II	24	18	9	Fair
Arthroplasty (cup)	Posterior	II	32	14	2	Good
Arthroplasty (cup)	Posterior	II	45	52	1	Good
Arthroplasty (cup)	Posterior	II	41	60	5	Poor
Arthroplasty (cup)	Posterior	II	28	120	12	Fair
Arthroplasty (without interposition of cup)	Posterior	II	27	24	15	Good
Arthroplasty (cup)	Posterior	IV	51	24	3	Good
Arthroplasty (cup)	Central	III	44	9	9	Good
Arthroplasty (fascial)	Posterior	I	28	36	10	?
Arthroplasty (fascial)	Posterior	II	23	18	14	Poor
Arthrodesis	Posterior	I	57	204	1	Good
Arthrodesis	Posterior	I	38	5	8	Good
Arthrodesis	Posterior	III	32	5	3	Good
Arthrodesis	Posterior	III	35	3	1	Good
Arthrodesis	Posterior	III	33	8	27	Good
Arthrodesis	Central	II	32	36	1	Good
Arthrodesis	Central	III	54	120	10	Good
Arthrodesis	Central	III	36	36	9	Good
Whitman Reconstruction	Posterior	IV	73	13 days	1	Fair
Osteotomy*	Posterior	II	64	96	3	Good
Osteotomy*	Posterior	III	53	48	1	Good
Osteotomy*	Posterior	III	35	120	1	Good

* Spontaneous fusion.

poor results in the hip in patients with complete recovery of the nerve and in others with no nerve recovery. Of the seventeen patients with nerve injury, there was no nerve recovery in three; there was complete recovery in three; there was 50 per cent. recovery in six; there was 25 per cent. recovery in one; and there was 75 per cent. recovery in two. In two of the patients, the degree of recovery is unknown.

Of two patients with dislocation, Grade I Central, one sustained an injury to the peroneal portion of the nerve, and the other an injury to the tibial portion. In both 50 per cent. recovery was obtained. Obviously, these nerves had been injured by direct trauma. Two patients with nerve injury had posterior dislocation, Grade I; in one there was complete recovery, and in the other there was 50 per cent. recovery.

One patient was found at operation to have a fragment of bone five centimeters long and one centimeter in diameter through the center of the sciatic nerve. The bone was removed, and within nine months there was complete recovery of the nerve. As a rule, the period of maximum recovery of the nerve in these patients was between one and two years.

It is the opinion of the authors that if, after manipulative reduction, the posterior rim fragments do not fall into correct position and the symptoms of sciatic-nerve injury persist for one to two weeks, open reduction and exploration of the nerve is indicated. This is particularly true in patients with posterior dislocation, Grade II and Grade III.

CALCIFICATION OR MYOSITIS OSSIFICANS

The authors were surprised to find that of the ninety patients treated by manipulation, myositis ossificans developed in only two. Calcium deposits or myositis ossificans developed to some extent in the majority of the patients treated surgically, especially in those who were operated upon through posterior incisions (Figs. 1 through 2-C).

Contrary to the observations of Watson-Jones and of Armstrong, in the patients in this series early active exercise appeared to have little effect upon the development of myositis ossificans. Böhler advises early active exercise, even while the patient is still in traction. For unstable posterior and central dislocations, he recommends placing the patient in skeletal traction on a Braun-Böhler frame and beginning "sit-up" exercises to produce motion in the hip. In the authors' hands this has proved a successful method of treatment.

RESULTS OF RECONSTRUCTIVE SURGERY FOLLOWING DISLOCATION

The results of reconstructive operations in so small a group of various types of dislocation of the hip are of little significance, but are presented here for completion of the analysis (Table XIII). The results previously described in five patients who had had primary reconstructions are included in this summary.

Nine of the patients had Vitallium-cup arthroplasties performed. In these, the results were good in five, fair in three, and poor in one. In two arthroplasties, fascia was interposed; the result was poor in one and unknown in the other. In one patient, who had had an arthroplasty without the interposition of a lining, a good result was obtained.

Arthrodesis was performed in eight patients, with uniformly good results. Three others had spontaneous fusion; in each a good result was obtained after corrective osteotomy. Another, a woman, seventy-three years old, with a posterior dislocation, Grade IV, (mentioned earlier), was treated primarily by a Whitman reconstruction; the result was fair.

The arthroplasty and arthrodesis were done in patients in a relatively young age group. As pointed out by Phemister [12, 13], Thompson and Epstein, and many others, arthrodesis, when successful, gives better results than any other type of reconstructive procedure. It is plausible that the trauma to the acetabulum and adjacent tissues establishes a reaction and proliferative response conducive to fusion. If this is true, additional surgery on the acetabulum itself, such as an osteotomy through the posterior third, should be an adjunct to fusion in all arthrodeses.

Each surgeon has his own idea of the proper reconstructive operation to be used in the presence of poor results or signs of their approach. It behooves the surgeon to offer the patient an alternative procedure before arthritis, avascular necrosis, and other complications develop which contribute to failure of the treatment. If the cases which are destined to fail can be determined early, according to the type and grade of the injury, the time the dislocation remained unreduced, and other factors which influence the outcome, much suffering and loss of time on the part of the patient can be avoided. Boyd's interesting experiments with radio-active phosphorus (P^{32}) to determine the amount of blood circulating in the head of the femur following fracture of the femoral neck, if successful, will certainly be applicable to dislocations. This should be helpful in the selection of the most suitable operative procedure.

DEATHS

In the group of patients treated surgically there were no deaths, but there were five in the group treated by non-surgical methods. Four of these occurred prior to 1936 and were the result of severe shock, visceral injuries, and secondary complications. Only one patient has succumbed during the past sixteen years; this was a man with internal injuries who was admitted in severe shock. He never regained consciousness and died on the day

of admission. This decline in mortality is attributed to modern antibiotic therapy, associated with advances in the treatment of shock and of visceral trauma.

COMMENT

In reviewing these cases, the authors feel that several facts are worthy of mention.

In 1936, Campbell reported eighty posterior dislocations of the hip, classified according to the extent of the displacement as seen in the roentgenograms. He stressed the necessity for lateral or stereoscopic views, lest slight displacements or subluxations be overlooked. The experience of Thompson and Epstein substantiated this point; in a number of their cases the displacement was not recognized until lateral roentgenograms were made. In some of our patients, lateral or stereoscopic views were necessary after manipulative reduction to demonstrate a persistent dislocation. When this condition is present—that is, when there is a disturbance in Shenton's line or a narrowing of the superior joint space—one must watch for subluxation and for chips or loose fragments in the acetabulum.

The authors would like to emphasize their concept of the surgical treatment for comminution of the acetabulum. First in importance is the immediate restoration of the head of the femur to the acetabulum. If the patient's general condition will not permit an open reduction within twelve to twenty-four hours after injury, the dislocation should be reduced by closed manipulation and maintained by traction. Surgery may be safely delayed for a week or ten days. Reduction and release of tension on the capsule, with its inherent blood supply, is more essential to the preservation of the integrity and function of the hip than is the replacement of the fragments of the acetabulum. At operation, the larger fragments should be restored to their normal positions, and sufficient internal fixation should be employed to ensure stability. It is imperative that any chips of bone or fragments of soft tissue be removed from the joint before conclusion of the operation.

In the authors' opinion, manipulative reduction is best accomplished by the Stimson manoeuvre; we have found it less traumatic to the patient and less strenuous for the operator. Unfortunately, this procedure is too seldom employed.

Approximately 30 per cent. of our patients were treated elsewhere initially and reduction was done by other physicians; they were then referred to the Clinic because of severe associated injuries or impending complications. We may assume, therefore, that many patients with uncomplicated dislocations, which are reduced by their local physicians, show an excellent or good result. This suggests a hopeful aspect in an otherwise rather discouraging prognosis of the results in treatment of traumatic dislocation of the hip.

Associated fractures and injuries did not appear to affect directly the end results in our patients, although in a number of patients such complications delayed reduction and contributed to degenerative changes.

The differential diagnosis between avascular necrosis and degenerative arthritis is often difficult. Transitory or permanent increase in density or cystic changes in the head and neck of the femur are undoubtedly due to vascular disturbances. Such changes may logically be called avascular sclerosis or necrosis. The authors have attempted to draw a distinction between arthritis and avascular necrosis, basing their diagnosis of avascular necrosis upon the presence of infarction in the femoral head. Some authors prefer to combine these conditions in estimating the poor results. The authors believe, however, that a distinction between the two permits a more comprehensive study of the results.

Narrowing of the joint space indicates cartilage degeneration and inevitable arthritic changes with spurs or the formation of osteophytes. These proliferative changes are nature's response to irritation from incongruity of the joint surfaces and connective-tissue degeneration. This is borne out in the twenty-five patients with avascular necrosis, since all exhibited arthritic changes.

The number of cases studied in this analysis is small, but it is sufficient to indicate a

trend and to be helpful in the formulation of a more comprehensive plan of treatment for fracture-dislocation of the hip.

CONCLUSIONS

Dislocation of the hip is an emergency demanding immediate reduction.

Manipulative reduction should take precedence over treatment of all other skeletal injuries and even abdominal injuries. Open reduction of the acetabulum may be delayed, provided the dislocation of the femoral head has been reduced.

Postoperative immobilization is necessary only to maintain stability.

If fractures are stable, there is no indication for prolonged restriction of weight-bearing.

Early, active, and vigorous exercise to restore muscle function and to prevent degeneration of the articular cartilage is a major feature of therapy. Early exercise does not tend to promote the deposition of calcium or the development of myositis ossificans.

The age of the patient has little influence upon the end result.

Avascular necrosis is the result of disruption of the blood supply to the femoral head, and is possibly the result of intracellular molecular changes in the femoral head incidental to force and counterforce imposed at the time of injury.

The average rate of the development of avascular necrosis is the same, regardless of the method of treatment.

Arthritis develops in direct proportion to the severity of the fracture and the extent of vascular damage.

Injuries of the sciatic nerve warrant exploration if their effects persist for two weeks without improvement.

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AN OPERATION FOR STAPLING VERTEBRAL BODIES IN CONGENITAL SCOLIOSIS *

BY ALAN DEFOREST SMITH, M.D., WILLIAM H. VON LACKUM, M.D., AND ROBERT WYLIE, M.D., NEW YORK, N. Y.

From the New York Orthopaedic Hospital, New York

Scoliosis of the so-called idiopathic type and that caused by poliomyelitis, if severe enough to necessitate surgery, usually can be treated successfully by correction in a hinge-turnbuckle or transection jacket, followed by spine fusion. A small group of cases of scoliosis in infants and young children, congenital in origin, still pose a difficult problem, however. If there is a hemivertebra or other vertebral anomaly, the curve may be too rigid to be corrected by a jacket, and spine fusion may not check the progress of such a deformity. Furthermore, spine fusion in the thoracic region in an infant or very young child, by retarding growth in the posterior bony elements more than in the bodies, may result in a lordotic deformity with narrowing of the anteroposterior diameter of the chest as growth proceeds.

A group of ten cases were reported by H. L. von Lackum and Smith in 1933 in each of which the hemivertebra was removed. In all but one of these patients the curvature was in the lumbar region, and it was considered too hazardous to remove such vertebrae in the thoracic area. Following this report, several additional patients were operated upon. The results were satisfactory in the majority, but in several patients a severe kyphosis resulted.

Philip Wiles performed a similar operation in two young children in whom there was a severe curve in the thoracic region. He approached the bodies from a posterolateral exposure after resecting several ribs. In both cases the result was vitiated by development of a severe kyphosis. One of the patients died three years after operation.

Nachlas and Borden [3,4] applied to the spine the method used by Blount for arresting growth in the extremities by placing staples over the epiphyseal plates. They produced scoliosis experimentally by placing staples in the vertebrae of dogs, thus arresting growth on the side operated upon. They introduced the staples into the bodies through the pedicles by a posterolateral approach. Later they were able to correct the curves so produced by placing staples in the opposite sides of the vertebrae. They reported that they had applied the method in three children.

* Read by Dr. Smith at the Annual Meeting of The American Orthopaedic Association, Hot Springs, Virginia, June 29, 1953.

The work of these authors promised to open an entirely new avenue of approach to this difficult group of cases. It seemed to us, however, that there might be some advantages in placing the staples directly into the vertebral bodies on the convex side of the curve and that this might be easier and more effective than to introduce the staples through the pedicles. Our first idea was to make the approach through a posterolateral incision with resection of the posterior parts of the corresponding ribs and transverse processes. Two such efforts demonstrated that this was not an easy procedure and we were persuaded by Dr. Bruce Hogg and one of the authors of this paper (Dr. Robert Wylie) that the vertebral bodies would be more accessible by the transthoracic route. This proved to be the case. Two patients have been operated upon in this manner, with resection of a rib and exposure of the spine by retraction of the lung. The exposure thus afforded is surprising. In scoliosis the vertebrae are rotated to the side, while the aorta and vena cava remain on the concave side and offer no obstacle to the operation. It is advisable to remove a rib attached to one of the uppermost vertebrae in the area to be operated upon; in this way, when the ribs are spread apart by the special retractor, more space is gained below than above. If necessary, one or two additional ribs may be divided.

Usually the intervertebral discs are easily identified, but in one case they were not, because of thickening and congestion of the periosteum of the bodies. A wire staple is introduced into two contiguous bodies which straddles the intervertebral disc and the two epiphyseal plates. A roentgenogram is then made to check the location of the staple and more staples are placed at each level. Some difficulty may be encountered in placing the staples in the end vertebrae, but this may be facilitated by the use of an offset staple holder and driver, or, if necessary, by division of another rib. After all of the staples have been placed, another roentgenogram is made.

It would be quite easy, if desired, to place bone grafts across the vertebral epiphyses, according to Phemister's method of arresting growth in the extremities. This was done by one of the authors (von Lackum) in a case of congenital scoliosis. We believe, however, that in most instances it is better to allow for later resumption of growth if this should be found advisable.

The wound is closed with interrupted sutures and a catheter is placed in the pleural cavity and is usually allowed to remain, sutured to the chest wall, for from twenty-four to forty-eight hours. If the pleural cavity is dry, if there is no oozing, and if the lung expands well, the catheter may be removed when closure is complete.

It is strongly advised that a surgeon experienced in thoracic surgery assist in this part of the operation. Intubation is begun before the operation and positive pressure is maintained while the thoracic cavity is open. It is well to make a roentgenogram of the chest within a few hours after operation to ascertain that the lung has expanded. The patient may get out of bed within two days after operation and ordinarily is ready to leave the hospital at the end of ten days. No jacket or other form of support is necessary.

In curvatures involving the lumbar spine, the vertebrae may be approached by a posterolateral incision through the thoracolumbar fascia, lateral to the sacrospinalis muscles, and extended along the mid-portion of the crest of the ilium. The peritoneum is pushed forward without being opened and the vertebral bodies are seen medial to the psoas muscle. The incision is the same as that for a lumbar sympathectomy by the retroperitoneal route, or for exposing the kidney or ureter. Here also the approach to the vertebrae is made easier by their rotation incidental to the scoliosis. For exposure of the twelfth thoracic and first lumbar vertebrae, resection of the eleventh and twelve ribs may be necessary; and, in order to get at the body of the twelfth thoracic vertebra, the diaphragm must be separated. This was done in one of our cases and offers no particular difficulty.

This report must be offered as a preliminary one, but the results thus far indicate that growth has been arrested on the sides of the vertebral bodies in which staples were inserted. In the three patients who have been followed long enough to warrant such an ob-

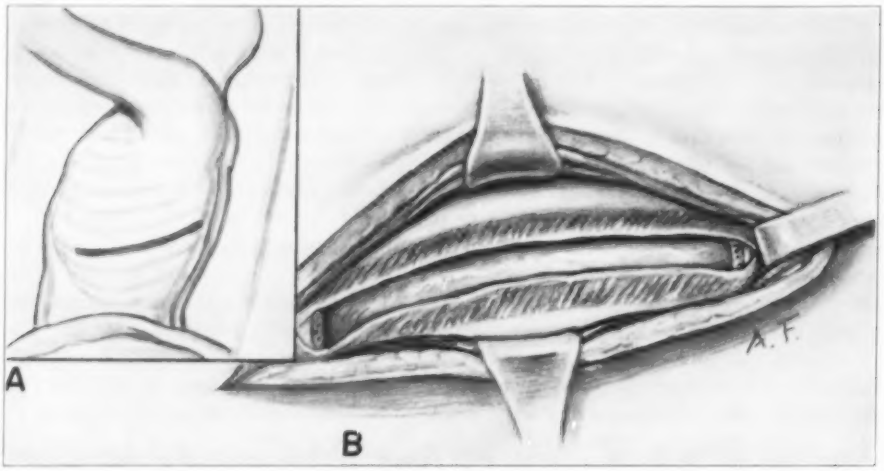

FIG. 1

FIG. 2

Fig. 1. *A:* Showing the line of incision over the eighth rib. *B:* The pleura is exposed by resection of part of the rib.

Fig. 2: The pleura has been opened and the ribs have been retracted. The vertebral bodies are exposed and a staple is inserted into two vertebrae. The lung is retracted by a sponge. The diaphragm is seen below the lung on the left.

Fig. 3. *A:* Staples have been placed into five vertebral bodies. *B:* The diagram indicates the location of the staples.

servation, there has been no increase in the curve in the area in which the staples were placed. In two of the patients with thoracic scoliosis, the error was made of not including enough vertebrae at the lower end of the curve, and there has been an increase in the deformity in those vertebrae which were not treated. A secondary curve also has developed in the opposite direction below the primary one, which it will be necessary to correct by a transection jacket followed by spine fusion. In the lumbar curve there has been no increase in deformity, but the trunk is so badly off balance, because of the inability of the thoracic spine to develop a compensatory curve, that further treatment is indicated. It is planned to remove the hemivertebra in the left mid-lumbar region with parts of the contiguous bodies, if necessary, and thus to reduce the lumbar curve.

All of the patients treated thus far have been beyond the optimum age, and we believe that the results would have been better had the operations been done when they were younger, preferably between two and four years of age. We believe, however, that the valid-

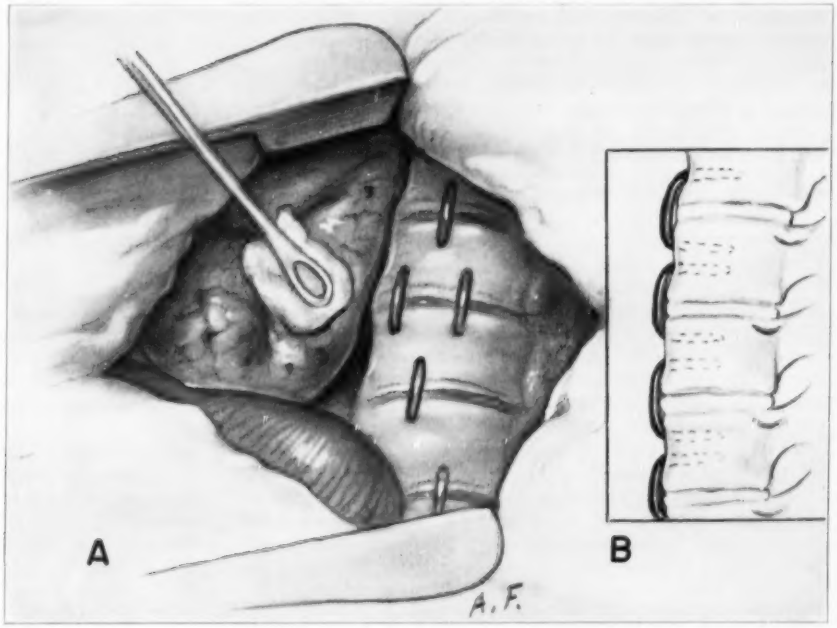

FIG. 3

ity of the method has been established. It was also hoped that, in addition to preventing increase in the curves, the stapling might actually reduce the curve by arresting growth on one side and permitting it to continue on the opposite side, as is done in knock-knee and bow-leg deformities, but this has not occurred. It is still possible that this effect may be obtained as growth continues in these patients.

The following are the case histories of the three patients with a sufficiently long follow-up to be reported:

CASE 1. A. B., a six-year-old girl, was first seen in March 1945. A sinus due to a congenital rest had been excised from the mid-line of the neck in the suboccipital region in 1943. A deformity of her thorax and left shoulder was noted in 1944. This was due to a high upper left thoracic scoliosis. Roentgenograms showed a left curve from the third to the seventh thoracic vertebrae, caused by a hemivertebra at the sixth thoracic level. On April 24, 1945, a Hibbs spine fusion was done from the fifth to the seventh thoracic vertebrae in an effort to prevent increase in the deformity. Although fusion of these vertebrae took place, the scoliosis continued to increase and in March 1951 it had become severe, with the additional development of a right thoracolumbar curve.

Since a posterior spine fusion had failed to arrest the deformity, it was decided to place staples across the epiphyseal plates and into the bodies of the vertebrae at the apex of the curve. Dr. Bruce Hogg, a thoracic surgeon, was called in consultation and was of the opinion that the upper thoracic bodies could be approached by a transthoracic exposure. He agreed, however, to attack the bodies by resecting the posterior parts of the ribs and retracting the pleura laterally.

This was done on March 23, 1951, when the patient was eleven years old. Dr. Hogg resected the posterior portions of the fourth to the seventh ribs, inclusive. The exposure of the vertebral bodies was more difficult than had been anticipated, but it was possible to place staples in the left sides of the bodies of what were thought to be the fourth to the seventh thoracic vertebrae, straddling the intervening discs and adjacent epiphyseal plates. Although this was checked by a roentgenogram made on the operating table, it was found subsequently that the staples actually had been placed in the third to the sixth bodies, inclusive. The course after operation was without any serious complication. The patient was allowed to get up on the day following operation and went home on the ninth day

Roentgenograms made twenty-six months after the operation showed that there had been no measurable increase in the deformity in the area stapled, but that the long right thoracolumbar curve below the area had

increased considerably. It is planned, therefore, to correct this as much as possible in a transection jacket and to do a spine fusion over the area of the secondary curve.

It is believed that, had the stapling been done at an earlier age, and had it included two or three more vertebrae below, the result would have been much better.

CASE 2. C. F., a girl, seven and one-half years old, was admitted to the New York Orthopaedic Hospital on May 8, 1950. She had been a patient in another hospital, where she had been under observation for scoliosis. She had right cervical, left thoracic, and right thoracolumbar curves. The left shoulder was elevated and the left scapula and right hip were prominent. Roentgenograms showed that the left curve from the third to the seventh thoracic vertebrae was 43 degrees and the right curve from the seventh thoracic to the third lumbar vertebrae was 26 degrees. It was decided to staple the bodies of the third to the seventh thoracic vertebrae, inclusive, but operation was deferred because of an intercurrent infection.

On November 8, 1950, the left posterior thoracic area was exposed by Dr. von Lackum through a longitudinal incision to the left of the mid-line. The muscles were split, the left transverse processes of the sixth and seventh thoracic vertebrae were removed, and a piece of the proximal end of the seventh rib was resected. The pleura was retracted laterally, and a staple was driven into the bodies of the sixth and seventh thoracic vertebrae. The procedure was difficult and bleeding was profuse. It was decided, therefore, not to attempt to complete the stapling of the other bodies.

Two weeks after the operation the patient began to have a headache, and signs of meningitis developed. She was transferred to Babies Hospital, where bloody spinal fluid was obtained by lumbar puncture. The spinal tap was repeated several times, and the fluid was clear at the last aspiration. It was believed that there might have been a subarachnoid hemorrhage caused by the operation, but the possibility of an abnormality in the arterial tree of the central nervous system was considered and it was decided to make an arteriogram. This was carried out after a subsequent admission to the Hospital on January 18, 1951. An arteriogram of the right carotid artery was normal. Following this, dysentery from a Salmonella infection developed.

The patient was again admitted to the New York Orthopaedic Hospital in July 1951, and, after a consultation with Dr. Robert Wylie, it was decided to attempt to staple the bodies of the fourth to the eighth thoracic vertebrae by an intrathoracic approach. On July 25, 1951, Dr. Wylie resected the fourth rib and a

FIG. 4-A

FIG. 4-B

Fig. 4-A: Congenital scoliosis of undetermined origin in a seven-year-old girl before operation.

Fig. 4-B: Roentgenogram made after insertion of staples into the bodies of the eighth to the twelfth thoracic vertebrae.

small segment of the third rib on the left side. This afforded an excellent view of the thoracic spine and staples were placed in the bodies of what were believed to be the fourth to the eighth thoracic vertebrae. A portable x-ray showed, however, that actually the third to the seventh thoracic vertebrae had been included. In order to obtain a satisfactory exposure of the eighth thoracic vertebra, it would have been necessary to resect the fifth rib, and it was decided that the stapling of this vertebra was not necessary. The incision was closed, and a fenestrated catheter was left in the seventh interspace. This was removed on the following day. Convalescence was uneventful. The patient became ambulatory on the third day and was discharged from the Hospital on the fifteenth day.

Physical examination and x-rays subsequently have shown that there has been no increase in the deformity in the area from the third to the seventh thoracic vertebrae, in which the staples had been placed, but that the curve has increased below the seventh thoracic vertebra, demonstrating that the area included in the operation was insufficient. It is now planned to decrease the prominent right thoracolumbar curve by a jacket and to perform a fusion of this area.

In this case the result would probably have been better if the stapling had been done when the patient was younger and if it had been extended downward.

Case 3. K. L. F., a girl, two and one-half years old, was seen in the Neurology Clinic of the Columbia Presbyterian Medical Center in May 1947, because of a deformity of her spine. She was studied carefully and no neurological disturbance was found. She was referred to the New York Orthopaedic Hospital on August 31, 1950. At that time there was a marked left lumbar scoliosis with very little compensation in the thoracic region. Roentgenograms showed a right curve of 10 degrees from the first to the eleventh thoracic vertebrae. There was a 32-degree left curve from the eleventh thoracic to the fifth lumbar vertebrae. There were multiple developmental anomalies of the vertebrae, including a hemivertebra in the lumbar region. It was advised at that time that correction of the lumbar curve be attempted and that a hemifusion on the left side of the lumbar spine be effected, but the father refused to give permission.

The patient finally was admitted to the New York Orthopaedic Hospital on September 28, 1951. She was then nearly seven years of age. The left lumbar scoliosis had increased markedly, and she was badly off balance, since a compensatory curve could not develop in the thoracic spine because of the numerous anomalies in that area. It was decided at this time to place staples in the vertebrae involved in the left lumbar curve. On October 12, 1951, with the assistance of Dr. Robert Wylie, an incision was made from the twelfth rib to the anterior part of the iliac crest on the left side. The thoracolumbar fascia was divided and the transversus abdominis and internal oblique muscles were partly detached from the ilium. To extend the exposure upward, parts of the eleventh and twelfth ribs were resected. At one point the pleura was opened and was immediately closed by sutures. The lower leaflet of the diaphragm was incised in order to expose the body of the twelfth thoracic vertebra. The rotation of the spine to the left made the vertebrae easily accessible, and wire staples were placed in the twelfth thoracic to the fourth lumbar vertebrae, with each staple in two contiguous vertebrae and straddling the intervening disc. The position of the staples was checked by x-rays. The course after operation was uneventful and the patient sat up on the second day.

Eighteen months after operation there was no increase in the lumbar curve, but neither was there evidence of decrease in the deformity, and the patient still was badly off balance because of lack of compensation in the thoracic area.

It is believed that, in order to improve this situation, it will be necessary to remove the hemivertebra and perhaps parts of the contiguous bodies in the lumbar region and thus materially reduce the lumbar curve.

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DISCUSSION

DR. I. WILLIAM NACHLAS, BALTIMORE, MARYLAND: The authors have presented a straightforward and factual report of an operative treatment for congenital scoliosis. As such, their paper is a valuable addition to the orthopaedic literature, but it has greater significance because in a broader sense they have blazed the trail in the relatively unexplored field of growth control in vertebral bodies as a means of combating spinal curvature. In principle and technique, the lesson of their work is applicable to the larger and more perplexing problem of idiopathic adolescent scoliosis. Time permits me to discuss only three facets of their work which should be stressed particularly.

The first of these is the operative approach. The transthoracic approach to the spine used by the authors has several merits. It permits free inspection of the operative site and reveals the pathological changes which are present. Dr. Smith indicated some of the operative findings in his cases. For example, he found that there is displacement of the aorta and the vena cava to the concave side, as well as congestion and periosteal thickening at the operative levels. Of great importance is the opportunity afforded to insert the staples with technical ease. In our experimental work, Dr. Borden and I have tried the anterior approach on animals and have discarded it in favor of the posterolateral approach. I have used the posterolateral approach on the children on whom I have performed this operation. There are several reasons why this approach should not be discarded, but time does not permit their discussion.

Second, there is the question of the growth-restraining medium, in this case, the staple. The design of the staple is important. As several of you know, in my first attempt at growth control on a child, in 1939, wire was used and it promptly cut out. In the experimental work, we used wires and found they pulled out rather than cut out in a number of cases. In the children more recently treated, the staples used had flat, rather broad surfaces. Even with these, one must guard against the pulling out of the staples. The experience of the authors in the cases reported today makes it possible that their technique will avoid the complications we encountered. They bridge only one intervertebral space with each staple, while in our cases one staple bridged or spanned several vertebrae. The amount of force generated in the growth of three or four vertebrae is far greater than in that of a single one. It is possible that I shall accept the authors' type of treatment, but I shall first follow the course of their patients as I have been watching mine over the years.

Another question: Is it enough to put in a *passive* restraint, such as the staple, in all of these children? Certainly in the older children the growth factor is not great. Should we not have something with a spring to it, to serve as an *active* compressing factor? I cannot answer these questions. We are still following our patients and hope we can report on them at a later date.

With regard to the authors' results, they report that the progress of the deformity in their cases was stopped, but that there had been no correction in the curvature of the stapled segment. They expressed the belief that time and growth may actually help to correct the curve. This is the desideratum, and it may logically be anticipated that, if normal growth takes place and if the staples are properly placed, correction rather than mere retention will follow. Skeptics might argue that these curves might have become arrested spontaneously. Yet the authors have demonstrated beyond doubt that, in those areas in which growth was controlled, the deformity has not increased, while in the same patients the involved regions — above or below, or both — which were not stapled have shown increase in deformity.

DR. J. R. MOORE, PHILADELPHIA, PENNSYLVANIA: When Dr. Nachlas presented his work on experimental scoliosis at Virginia Beach three years ago [a], I had the privilege of discussing his paper and presented three cases of scoliosis and one of kyphosis in which growth arrest had been attempted by stapling.[b] The spinous processes were used in the case of round back and the transverse processes on the convex side were used in the three cases of scoliosis. For the first two years, the deformities in all four cases seemed to be remaining stationary. It has now been slightly more than four years since the staples were employed. There has been a return of the curves to the original deformity and it is quite obvious that the staples have been of no use. In every instance they have shown evidence of cutting through bone. I am thoroughly convinced that stapling has no place in the correction of scoliosis unless possibly the staples are employed in the earliest phase, particularly before rotation has taken place. I have had no experience with such cases. The patients referred to all had lateral curvatures combined with rotation. I feel certain that correction through growth arrest is quite impossible.

a. NACHLAS, J. W., and BORDEN, J. N.: The Cure of Experimental Scoliosis by Directed Growth Control. J. Bone and Joint Surg., **33-A**: 24–32, Jan. 1951.

b. MOORE, J. R.: Discussion of [a]. J. Bone and Joint Surg., **33-A**: 32–33, Jan. 1951.

DR. SMITH (closing): I would like to make one point: I believe that this operation is applicable only to infants and very young children. There must be a long growth potential if this operation is to be successful. In the average case of scoliosis, therefore, which as a rule is not discovered until adolescence, this method probably will not be very successful. I think it is most promising in infants and young children, particularly in the thoracic region, where so far we have been unable to control the curvature in any other way.

PANTALAR ARTHRODESIS

A One-Stage Operation *

BY WALTER S. HUNT, JR., M.D., AND HUGH A. THOMPSON, M.D., RALEIGH, NORTH CAROLINA

A fusion of all the joints about the talus has long been recognized as a means of stabilizing the paralytic flail foot. Yet many younger orthopaedists have never heard of completely removing the talus and replacing it as a graft. This method is not original. It has been known for many years, having first been reported in 1911 by Lorthioir, who used it in eight cases for correction of equinovarus deformity, paralytic or congenital in origin. Crainz in 1924 also wrote of seven panarthrodeses secured by astragalectomy and replacement of the denuded bone. Modifications have been described by Albee and by Steindler [5,6]. Ansart in 1951 mentioned briefly the same operation as that used by the authors. In spite of this impressive background, the procedure today is rarely used.

The purpose of this paper is to describe the operation in detail and to show with our small series of thirty-eight cases that it is a simple, effective procedure, singularly free of complications or danger.

Indications

In general, instability, deformity, and pain cover the main reasons for surgery. The indications for the operation in our opinion are somewhat broader than those generally

FIG. 1

FIG. 2

FIG. 3

Fig. 1: Photograph showing wide exposure of head, neck, and body of the talus.

Fig. 2: Photograph showing Hatt spoons for easy removal of the talus.

Fig. 3: Showing the foot after replacement of the talus.

* Read at the Annual Meeting of the American Medical Association, Orthopaedic Section, June 2, 1953.

accepted. We feel that all flail feet, all complete drop feet, and all calcaneus deformities are best treated by pantalar fusion. The better the gluteal and hamstring musculature, the better the result. Great quadriceps weakness which requires wearing of a brace can be overcome by the operation if the foot is placed in sufficient equinus. Severe genu recurvatum, genu varum or genu valgum, and flexion contractures diminish the chances of a good result. Although in most of the patients operated upon poliomyelitis was the cause of the paralysis, the operation was also performed, as will be seen, for weakness due to other causes and for fracture-dislocation of the talus, as well as for post-traumatic arthritis.

Operative Technique

The patient is supine, with a pneumatic tourniquet about the upper portion of the thigh and the extremity in internal rotation. The universal anterolateral approach is employed. It is preferable to the Kocher or Whitman incision, as the skin heals better and the external saphenous nerve is avoided. The incision is made sufficiently long to allow easy medial retraction of the common extensors and the vascular bundle. The ankle and talonavicular joints are then opened (Fig. 1), the fore part of the foot is adducted, and the talar neck is grasped with a lion-jaw forceps. With a knife and a set of Hatt spoons (Fig. 2),

FIG. 4-A

Case 10. D. D. G., a nine-year-old white male with a flail right foot and ankle following poliomyelitis at the age of five. The photographs were made before operation.

FIG. 4-B

Photographs made after operation.

the talus is freed of all ligamentous and capsular attachments and is then removed. It is laid on a block and peeled of its cartilage, cortex, and ligaments, as much bone as possible being preserved, so that its approximate size and shape are retained. With curved chisels the articular cartilage of the tibia, fibula, calcaneus, and navicular are cleanly removed and then roughened with a small gouge, care being taken to avoid injury to the epiphyseal plate of the tibia and fibula. If correction of varus or cavus of the fore part of the foot is needed, appropriate wedges are removed from the calcaneocuboid joint.

The denuded talus is then replaced in its bed (Fig. 3); the wound is closed in layers; and the skin is sutured with catgut. The patient is then turned on his abdomen and, while the knee is held in flexion, a short plaster cast is applied, which is molded to secure accurate contact of the denuded surfaces and to correct all components of the deformity. The degree of plantar flexion varies but is usually neutral in the male and 8 to 10 degrees in the female. After the plaster boot has set, it is extended to include the thigh, with the knee held in slight flexion.

Postoperative Management

The after-care is the same as that used in any type of foot stabilization. Three weeks after operation the cast is removed, the wound is dressed, and roentgenograms of the foot are made. If changes are necessary, they can be made at

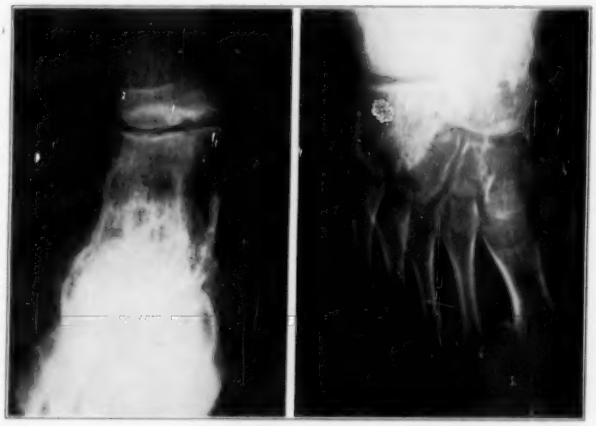

FIG. 4-C FIG. 4-D

Nine months after operation, roentgenograms showed solid fusion of the ankle and talonavicular joints.

FIG. 4-E

Lateral roentgenogram made nine months after operation.

this time by gentle manipulation under anaesthesia. A new toe-to-groin plaster cast is then applied which incorporates a metal walking iron.

ANALYSIS OF CASES

Forty one-stage pantalar arthrodeses according to the method described were done between March 1944 and August 1952. Two patients moved out of the State and could not be followed. Of the thirty-eight remaining patients, the senior author operated upon twenty-one and the junior author on seventeen. All operations were done at Rex Hospital, St. Agnes Hospital, or the Central Prison Hospital, Raleigh, North Carolina.

Age and Sex

Thirty-four of the thirty-eight patients were children; the youngest was eight and the oldest eighteen years old. The average age of the children at the time of operation was 11.1 years. Of the four adults the youngest was twenty and the oldest fifty-six, with an average age of thirty-two at the time of surgery. In the entire group there were eighteen females and twenty males.

FIG. 5-A

Diagnosis

Thirty-two of the children and one adult had paralysis as a result of poliomyelitis; in one the paralysis followed infantile cerebral palsy and in another it followed progressive muscular atrophy. Three adults had pantalar fusions because of injury, two for recent fracture dislocation of the talus and one for arthritis of the foot and ankle, the result of an unreduced dislocation of the talus.

FIG. 5-B

Fig. 5-A: Case 11. T. H., an eleven-year-old white female with a flail left foot and ankle resulting from poliomyelitis at the age of eight. The photographs show front and side views of the arthrodesed left foot.

Fig. 5-B: Lateral roentgenogram made five years after operation.

Deformity

Of the thirty-five paralytic feet operated upon, fifteen were simple flail feet with no muscle power except for perhaps a trace of either toe flexion or extension. Fourteen had almost flail or drop feet with varying amounts of varus or valgus of the fore part of the foot and of the heel. Five feet were weak with calcaneus, cavus, and varus or valgus deformity. One, the foot in the spastic patient, had a typical equinovarus deformity.

Extent of Fusion

In every case the entire talus was removed, denuded, and replaced. Thirty-one of the thirty-four children had a simple fusion of the joints articulating with the talus.

FIG. 6-A

FIG. 6-B

FIG. 6-C

FIG. 6-D

Fig. 6-A: Case 31. R. A. W., a nine-year-old white female with a drop-foot valgus on the right resulting from poliomyelitis at the age of four months. The photograph was made after operation.

Figs. 6-B to 6-D: Roentgenograms made eight years after operation.

Three had in addition a calcaneocuboid fusion. Three of the adults had pantalar fusions together with a sliding tibial graft, and only one had a simple pantalar fusion. An extra step in the four adults was a more thorough cleaning of all cortical bone, followed by roughening and drilling of the cancellous graft to permit easy revascularization.

Interval between Onset of Poliomyelitis and Operation

In the thirty-three patients operated upon because of paralysis following poliomyelitis, the average time interval between the onset of acute illness and the operation was 6.6 years. The shortest interval was eighteen months and the longest thirteen years.

Length of Immobilization

In spite of the added assurance of thorough roughening and drilling of the talus, together with a tibial-bone graft, the four adults required an average of three months longer than the children to obtain solid fusion. The average length of immobilization in the children was 4.8 months and in the adults 7.75 months.

FIG. 7-A

FIG. 7-B

Complications

Contrary to the almost universal belief that one-stage panarthrodesis by astragalectomy and replacement of the talus is an operation of considerable magnitude and accompanied by aseptic necrosis of

FIG. 7-C

Case 33. L. A. D., a twelve-year-old white male with an equinovalgus foot on the left resulting from poliomyelitis at the age of eleven months. The roentgenograms show the degree of fusion six months after operation.

the talus, sloughing, or infection, the authors encountered none of these complications. With a little practice, the operation is as simple as a triple arthrodesis or an ankle fusion. While some tali after the operation were more dense than the surrounding bone, the four pseudarthroses of the ankle in this series were attributed to distraction caused by the weight of the cast against the unopposed weak Achilles tendon. For this reason we feel it is preferable, especially in calcaneus deformities, to incorporate a tibial Steinmann pin in the plaster, not only to aid in the correction of calcaneus and cavus, but to maintain accurate and constant contact of bone between the talus and the tibia.

The one fracture of the talus, in Case 14, occurred following an injury one year after fusion. It healed uneventfully.

The one mild skin slough, in Case 38, had been predicted before fusion and occurred at the site of pressure in an eight-day-old unreduced dislocation of the talar neck and head where the overlying skin was paper-thin and discolored. It had completely healed before solid fusion was obtained.

Length of Follow-up

The average period of observation for the thirty-four children was 48.7 months (4.1 years), the shortest follow-up being nine months and the longest 111 months. In the four adults the average follow-up was 22.5 months, the shortest eleven months, and the longest forty months. The over-all observation period for the entire series was three years and ten months.

FIG. 8-A FIG. 8-B

Case 36. V. L. H., a colored female twenty-seven years old with traumatic arthritis of the left ankle and subtalar joints resulting from an old unreduced dislocation which had occurred two years previously. The roentgenograms were made before operation.

FIG. 8-C

Roentgenogram made one year after operation.

TABLE I

PANTALAR FUSIONS IN CHILDREN'S SERIES

Case No.	Age and Sex	Diagnosis	Deformity	Extent of Fusion	Time from Onset to Operation (*Years*)	Length of Immobilization (*Months*)	Complications	Length of Follow-up (*Months*)	End Result
1	12 M	Poliomyelitis	Flail foot (calcaneovarus)	Pantalar	4	4	None	60	Good (slight varus)
2	12 M	Poliomyelitis	Flail foot (equinovarus)	Pantalar	8	4	None	89	Fair (metatarsus varus, walks on toes)
3	8 M	Poliomyelitis	Flail foot (equinovarus)	Pantalar	3	4	None	24	Excellent
4	11 F	Poliomyelitis	Flail foot (equinovarus)	Pantalar	6	4	None	36	Good (slight valgus)
5	9 F	Poliomyelitis	Talipes equinovarus	Pantalar	8	6	Pseudarthrosis of ankle	111	Fair. Good after re-fusion
6	10 M	Poliomyelitis	Talipes equinovalgus (drop-foot)	Pantalar	6	5	None	23	Excellent
7	13 M	Poliomyelitis	Weak foot	Pantalar	1½	5	None	20	Excellent
8	16 F	Poliomyelitis	Flail foot	Pantalar	4	7	Pseudarthrosis of ankle	12	Fair (painless pseudarthrosis)
9	18 F	Poliomyelitis	Flail foot	Pantalar	13	6	None	60	Excellent
10	9 M	Poliomyelitis	Flail foot	Pantalar	5	5	None	12	Excellent
11	11 F	Poliomyelitis	Flail foot	Pantalar	3	5	None	67	Good (slight valgus)
12	15 M	Poliomyelitis	Weak (equinovarus)	Pantalar and calcaneocuboid	13	6	None	93	Good (slight varus)
13	10 F	Poliomyelitis	Flail	Pantalar	2	4	None	37	Excellent
14	8 F	Poliomyelitis	Flail	Pantalar	2	5	Fracture of talus	36	Good (slight calcaneus)
15	12 F	Poliomyelitis	Flail	Pantalar	11	6	Pseudarthrosis	60	Fair. Good after re-fusion
16	8 F	Cerebral palsy	Talipes equinovarus	Pantalar	7	4	None	48	Excellent

17	13 M	Poliomyelitis	Flail (calcaneocavus and valgus)	Pantalar	11	4	None	58	Good (slight calcaneus)
18	14 F	Poliomyelitis	Weak foot	Pantalar	2	7	Pseudarthrosis of ankle	11	Fair (painless pseudarthrosis)
19	10 M	Poliomyelitis	Flail foot	Pantalar	7	6	None	59	Good (slight calcaneus)
20	10 F	Poliomyelitis	Equinovarus with cavus	Pantalar and calcaneocuboid	6	4	None	24	Excellent
21	10 M	Poliomyelitis	Flail foot	Pantalar	8	4	None	108	Excellent
22	10 F	Progressive muscular atrophy	Talipes equinovarus	Pantalar	9	5	None	56	Excellent
23	10 M	Poliomyelitis	Flail foot	Pantalar	9	3½	None	18	Excellent
24	13 M	Poliomyelitis	Flail foot (equinovarus)	Pantalar	10	5	None	50	Excellent
25	9 M	Poliomyelitis	Flail foot (calcaneocavus)	Pantalar (with pins) and calcaneocuboid	5	5	None	106	Good (slight varus)
26	13 M	Poliomyelitis	Flail foot	Pantalar	9	4	None	60	Good (slight equinus)
27	9 M	Poliomyelitis	Calcaneocavo-valgus	Pantalar	6	4	None	36	Good (slight calcaneus)
28	13 F	Poliomyelitis	Flail foot	Pantalar	4	6	None	10	Fair (forward displacement of talus on tibia)
29	12 F	Poliomyelitis	Flail foot	Pantalar	9	4	None	36	Excellent
30	9 M	Poliomyelitis	Flail foot	Pantalar	3	5	None	24	Good
31	9 F	Poliomyelitis	Flail foot (drop-foot, valgus)	Pantalar	8	4	None	107	Excellent
32	12 F	Poliomyelitis	Flail foot (equinovalgus)	Pantalar	8	5	None	84	Excellent
33	12 M	Poliomyelitis	Equinovalgus	Pantalar	11	4	None	9	Excellent
34	9 F	Poliomyelitis	Flail foot	Pantalar	4	5	None	12	Excellent

TABLE II

SUMMARY OF CHILDREN'S SERIES

Average Age	Male (*No. of Patients*)	Female (*No. of Patients*)	Diagnosis	Deformity	Extent of Fusion	Average Time from Onset to Operation (*Years*)	Average Time of Immobilization (*Months*)	Complications	Average Time of Follow-up (*Months*)	End Result
11.14	17	17	Cerebral palsy, 1 Progressive muscular atrophy, 1 Poliomyelitis, 32	Flail, 14 Flail or weak with equinus and varus or valgus, 14 Flail or weak with calcaneovarus or valgus, 5 Spastic with equinovarus, 1	Pantalar, 31 Pantalar and calcaneocuboid, 3	6.65	4.8	Pseudarthroses, 4 Fractured talus, 1	48.7	Excellent, 17 Good, 11 Fair, 6 Poor, 0

TABLE III

PANTALAR FUSIONS IN ADULT SERIES

Case No.	Age and Sex	Diagnosis	Deformity	Extent of Fusion	Time from Onset to Operation	Length of Immobilization (*Months*)	Complications	Length of Follow-up (*Months*)	End Result
35	20 M	Fracture-dislocation of talus		Pantalar and tibial graft	1 day	9	None	19	Fair (forward displacement of talus on tibia)
36	27 F	Old subtalar dislocation	Talipes equinovalgus	Pantalar	2 years, 1 month	8	None	20	Excellent
37	28 M	Poliomyelitis	Flail foot	Pantalar and tibial graft	10 years	7	None	40	Excellent
38	56 M	Fracture-dislocation of talus		Pantalar and tibial graft	8 days	7	Mild skin slough	11	Good

End Results

The following criteria were used in evaluating end results:

Excellent

Solid fusion of all joints;
No deformity;
No pain;
Stability;
Satisfactory relationship of talus to tibia;
Heel-toe gait.

Good

Solid fusion of all joints;
Mild varus or valgus of fore part of foot;
No pain;
Stability;
Satisfactory relationship of talus to tibia;
Heel-toe gait.

Fair

Solid fusion of all joints but one;
Too much equinus, or mild varus or valgus;
Occasional discomfort;
Stability;
Less than satisfactory ankle mortise (talus displaced anteriorly on tibia).

Failure

Pseudarthrosis of more than one joint;
Aseptic necrosis of talus;
Instability;
Pain;
Recurrence of deformity.

Seventeen of the children and two adults (50 per cent.) were considered to have an excellent result, 31.6 per cent. had a good and 18.4 per cent. a fair result. There were no failures. Of the six children with a fair result, four had pseudarthrosis of the ankle; two of them had re-fusion with a good result. Re-fusion was not done in the other two, as the ankle was stable and painless. The fifth patient with a fair result had solid fusion of all joints but walked on his toes in some varus and had a painful callus beneath the fifth metatarsal head. The sixth child and the one adult with a fair result had occasional discomfort on long walks because of forward displacement of the talus on the tibia.

Of the thirty-five patients with paralytic feet, thirty-three had worn braces before the operation. Thirty of these were made free of braces by the pantalar fusion, three continued to use a brace, and three used crutches because of extensive paralysis of trunk and hip muscles.

Admittedly pantalar fusion has its limitations and disadvantages. At the outset our purpose was to show the simplest way to perform the operation, not necessarily to defend all pantalar arthrodeses. Yet we have been impressed with the improvement in functional capacity following such stabilization. All of the patients with an excellent or good result could walk half a mile without fatigue, unless there was extensive weakness of the trunk or hip muscles, or both. In the children's series the boys, almost without exception, participated in strenuous sandlot baseball and football, although they might occasionally call on a teammate to run for them. The girls enjoyed ballroom or folk dancing, but tap-dancing was out of the question. No great difficulty was encountered in walking on uneven ground, although ascending stairs and walking up inclines was not easy, particularly in those patients with poor quadriceps or hip extension.

The four adults resumed their previous occupations after surgery. They were respectively a housewife, a truck driver, a farmer, and a prisoner committed for life and doing heavy manual labor.

CONCLUSIONS

Pantalar fusion by astragalectomy and replacement of the denuded bone has its greatest usefulness in paralysis resulting from poliomyelitis, but can be used in other types of paralytic feet in children, as well as in adults, for new and old injuries which formerly were subjected to two arthrodesing procedures or an astragalectomy. All flail feet, all complete drop feet, and all calcaneocavus deformities due to paralysis are best treated by pantalar fusion.

NOTE: The authors would like to express their thanks to Dr. Landis Bennett, Department of Visual Aid, North Carolina State College, Raleigh, North Carolina, and to Mr. Lewis Watson for their help in preparing the photographs and moving pictures. To Dr. M. P. Rudolph, Chief of the Crippled Children's Section of the State Board of Health, Health Officers Dr. M. T. Foster, Dr. T. G. Basnight, Dr. Eugene Hardin, Dr. J. W. Wilcox, Dr. N. T. Ennett, Dr. A. C. Bulla, and their capable assistants we extend our sincere appreciation for their help and cooperation in making this survey possible.

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DISCUSSION

DR. ROBERT LEE PATTERSON, JR., NEW YORK, N. Y.: There have been over a period of time various reports on stabilization of the feet in poliomyelitis, expressing different opinions on the type of procedure indicated. Twenty years ago when I was a resident at the Children's Hospital in Boston, it was the general opinion that panarthrodesis was the operation of choice for flail feet. However, at the Hospital for Ruptured and Crippled astragalectomy was used and, when properly done, gave excellent results. From the work done at the Hospital for Special Surgery in 1949, it was quite obvious that stabilization by triple arthrodesis, whether of the Hoke, Brewster, or Lambrinudi type, did not give consistently satisfactory results in the correction of drop-foot. Without the benefit of muscle transplantation, drop-foot was still a problem. Stabilization of the foot and ankle for flail-foot, therefore, seems reasonable and, if the patient is old enough, it is indicated as the authors have stated.

Since I have not used the method of stabilization which they have described, my comments must be based on a comparison of this method with the old standard form of panarthrodesis. The comparison must be on the basis of the operative procedure, the complications, and the results. The latter should be evaluated from the standpoint of arthrodesis or fusion and not from a functional viewpoint since, as we stated, when the operation is indicated and fusion is obtained, the functional results are good regardless of the method used.

The removal, cleaning, and replacement of the talus seems to me a formidable procedure wrought with many possibilities of danger. If infection occurred, not even a good result could be obtained. Avascular necrosis with aseptic sequestration might be the outcome. On the other hand, long periods of immobilization for union pose an economic problem. However, the authors have not encountered these complications. Ansart [2], in 1951, in reporting on this operation, stated that it was more suited to the severely deformed foot with poor circulation. He gave no statistics on the number of cases or the end results, as the authors have, but his comments would lead us to believe that healing and infection were not major problems.

In our group of patients the average age, 20.7 years, was slightly higher than in Dr. Hunt and Dr. Thompson's. Of twenty cases, four cases of skin slough occurred, three of them after one-stage panarthrodesis. There were four cases with pseudarthrosis; two of these had to be considered failures after a five-year follow-up. I am convinced that a one-stage arthrodesis of the standard type should not be done on adult patients.

Under the system of grading used by the authors—a very strict system for which I congratulate them—they have listed as "fair" cases with one pseudarthrosis. I should like them to check further on this. Of our 305 stabilizations, 18 per cent. showed pseudarthrosis, but in 89 per cent. of this group the pseudarthrosis was in the talonavicular joint and often was asymptomatic. If the subtalar or the ankle joint showed failure of

fusion in the end, the case was considered a failure. The four cases with pseudarthrosis at the ankle will probably have to be considered failures.[b]

We therefore see that panarthrodesis performed in the routine manner and in one stage is not without complications, and that union of four joints does not always occur. Nevertheless, the authors have shown a good technique with good results and without severe complications and are to be congratulated on adding further experience to this type of operation.

We have used a Steinmann pin through the heel into the calcaneus, talus, and tibia to maintain bone contact. The loss of position at the first change of plaster was found, in our report, to be the second most common cause of failure in arthrodesis of the foot.

A final word of caution on the type of operation under discussion: If infection or necrosis is encountered, further measures may prove futile.

[a] ANSART, M. B.: Pan-Arthrodesis for Paralytic Flail Foot. J. Bone and Joint Surg., **33-B**: 503–507, Nov. 1951.

[b] PATTERSON, R. L., JR.; PARRISH, F. F.; and HATHAWAY, E. N.: Stabilizing Operations of the Foot. J. Bone and Joint Surg., **32-A**: 1–26, Jan. 1950.

DR. ROBERT J. JOPLIN, BOSTON, MASSACHUSETTS: The authors have presented the results of a series of cases successfully treated by a relatively new method which they feel is not well known or appreciated. Since any new method of treatment must be tested and the results critically analyzed before the method can be generally accepted, we are indebted to them for this valuable contribution.

Although the scope of conditions for which they recommend this method of treatment is rather broad, they specify certain limitations and warn against expecting the best results when genu recurvatum, genu varum, genu valgum, or flexion contracture is present. They also recorded certain minor complications. Nevertheless, I believe the good points of the method outweigh the bad. One aspect which impressed me more than all others was the time-saving factor.

Instead of performing the pantalar arthrodesis in one stage, we have attempted to get the same end result by a two-stage procedure, thinking, perhaps, that it is less shocking, or that, in certain cases, only one stage of the operation might be sufficient. Usually, however, the other part of the operation has had to be completed sooner or later. Furthermore, this two-stage, time-consuming procedure keeps the patient in the hospital longer and, in the end, costs more.

To illustrate this point, our orthopaedic residents, Dr. J. D. Lowell of the Massachusetts General Hospital and Dr. Walter Carver of the Veterans Hospital of Boston, have looked up the records of all pantalar operations performed during the past five years in their respective Hospitals.

At the Veterans Hospital our series (Table I) consists of only three adult patients, while the authors had four adults. Although this series is small, it demonstrates clearly the long delay before the final end result is reached by the two-stage method. For example, in the first case, the triple arthrodesis was followed by a toe-to-groin cast for about six weeks; after this the patient wore a plaster boot for six months, and then there was a delay (or convalescence) of eleven months before it was decided to do an ankle fusion. This was again followed by a toe-to-groin cast for six weeks and a boot for three months. The total period of time thus amounted to about two years. Although the result was rated "very poor", it should be pointed out that the patient was suffering from a self-inflicted wound and was known to be psychotic.

The second patient had a similar course, except that the delay was still longer. After the triple arthrodesis there was a five-year waiting period. The inevitable happened, the ankle fusion failed on the first

VETERANS ADMINISTRATION

1948–1952

		ANKLE FUSION						TRIPLE ARTHRODESIS						
NAME	AGE	Dx	FUSION	DATE	LL CAST	BOOT	FUP	Dx	DATE	LL CAST	BOOT	FUP	COMPLICATIONS	FINAL RESULTS
P.C.	23	TR ARTH	ADAMS	4/14/52	6 WKS.	3 MOS.	1 YR.	TR ARTH	3/20/51	?	6 MOS.	3 YRS.	S.I.W. SEVERE N.P. FACTOR	VERY POOR
J.S.	35	TR ARTH	ADAMS	8/48	?	4 MOS.	2 YRS.	TR ARTH	10/43	?	?	7 YRS.	8/48 ANKLE FUSION FAILED TO UNITE REFUSED C. BANK BONE (HATT) ON 4/49	VERY POOR
	35	NON UNION OF FUSION ABOVE	BONE BANK GRAFT (HATT)	4/49	1 WK.	3 MOS.	1 YR.						NONE	EXCELLENT
R.B.	52	TR ARTH	ADAMS	7/27/52	6 WKS.	3 MOS.	10 MOS.	TR ARTH	4/16/53	6 WKS.	6 WKS.	10 WKS.	ANKLE FUSION IN POOR POSITION POSTOP. MANIPUL. FOLLOWING DAY.	TOO SOON TO SAY

TABLE I

PAN-TALAR FUSIONS – M G H 1947-1953

CASE	AGE	SEX	DIAGNOSIS	SIDE FUSED	DEFORMITY	EXTENT OF FUSION	INTERVAL SINCE ONSET IN YEARS	LENGTH OF IMMOBILIZATION MONTHS	COMPLICATIONS	TIME FOLLOW UP MONTHS	END RESULT
1	42	F	TUBERCULOSIS	Rt	NONE	ANKLE AND SUBTALAR	41	2	NONE	58	EXCEL.
2	23	M	CLUB FEET	Rt	EQUINO-VARUS	ANKLE AND TRIPLE	23	2	NONE	56	GOOD
				Lft	EQUINO-VARUS	ANKLE AND TRIPLE	23	2	NONE	56	GOOD
3	18	M	CLUB FOOT	Rt	EQUINO-VARUS	ANKLE AND TRIPLE	18	3	SEPTIC HEMATOMA	24	EXCEL.
4	35	M	POLIOMYELITIS	Rt	EQUINO-VARUS	ANKLE AND TRIPLE	33	2	NONE	27	EXCEL.
5	42	F	CLUB FOOT	Lft	EQUINO-VARUS	ANKLE AND TRIPLE	42	2	NONE	26	EXCEL.
6	40	F	POLIOMYELITIS	Lft	EQUINO-VARUS	ANKLE & SUBTALAR & CALCANEO – CUBOID	37	$3\frac{1}{2}$	NONE	36	EXCEL.
	39			Rt	EQUINO-VALGUS	ANKLE AND SUBTALAR	36	$4\frac{1}{2}$	NONE	48	EXCEL.

TABLE II

attempt, and re-fusion was done nine months later with an excellent end result. The total period of time was about six years.

Finally, the course in the third case differed from that in the other two only in that the ankle fusion was done first. The time element was similar, with four and a half months in plaster, then three months' convalescence before the triple arthrodesis, which was followed by another three months in plaster. It is too soon for final evaluation, but so far a year has elapsed since the first-stage operation.

PAN-TALAR FUSIONS – M G H 1947-1953

CASE	AGE	SEX	DIAGNOSIS	SIDE FUSED	DEFORMITY	EXTENT OF FUSION	INTERVAL SINCE ONSET IN YEARS	LENGTH OF IMMOBILIZATION MONTHS	COMPLICATIONS	TIME FOLLOW UP MONTHS	END RESULT
7	27	M	MALUNION ANKLE FRACT.	Lft	EQUINO-VARUS	ANKLE AND TRIPLE	15	$3\frac{1}{2}$	NONE	36	EXCEL.
8	34	M	CLUB FOOT	Lft	EQUINO-VARUS	ANKLE AND TRIPLE	34	3	NONE	6	EXCEL.
9	29	M	POLIOMYELITIS	Lft.	EQUINO-VARUS	ANKLE AND TRIPLE	26	$2\frac{1}{2}$	NONE	9	EXCEL.
10	28	F	POLIOMYELITIS	Lft	EQUINO-VARUS	ANKLE AND TRIPLE	28	4	NONE	54	GOOD
11	18	M	TUBERCULOSIS	Rt	VALGUS DEFORMITY	PAN-TALAR	18	$3\frac{1}{2}$	NONE	10	EXCEL.
12	20	F	POLIOMYELITIS	Lft.	NONE INSTABILITY	TRIPLE AND ANKLE	3	$2\frac{1}{2}$	NONE	3	EXCEL.

TABLE III

A similar though less striking contrast is found in the twelve adult patients from the Massachusetts General Hospital (Table II). I shall give only a brief summary. Eleven of these patients had two operations and one (Case 11, Table III) fortunately had a one-stage pantalar arthrodesis; the diagnosis had been tuberculosis. The period of immobilization in this case was three and a half months; this compares favorably with the period of immobilization in the adult age group reported by Dr. Hunt and Dr. Thompson, and suggests that a similar result might have been expected in all our cases if we had followed their technique.

(*Continued on page 442*)

METAL ALLOPLASTY OF THE KNEE JOINT

An Experimental Study

BY E. J. MOEYS, M.D., UTRECHT, NETHERLANDS

From the Surgical Department, Universiteitskliniek, Utrecht*

Until the present time arthroplasty has been, on the whole, a not very satisfactory chapter in surgery. The plastic operation in which the ends of the bone are modeled into articular surfaces and in which transplanted fat or fascia takes the place of cartilage is an exceptionally difficult one, only mastered by few. Any other method by which this problem can be solved will therefore be welcome.

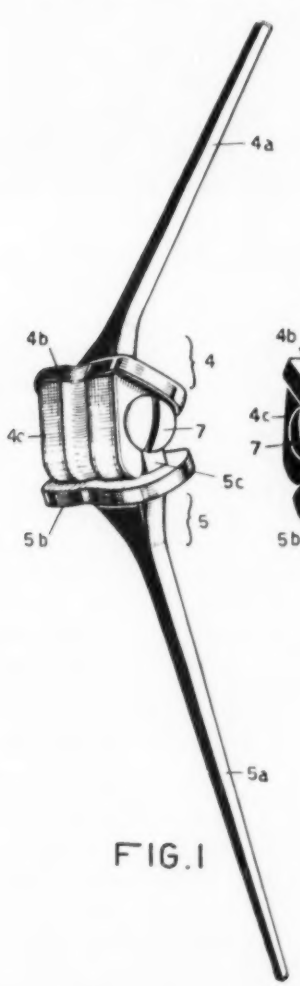

FIG. 1

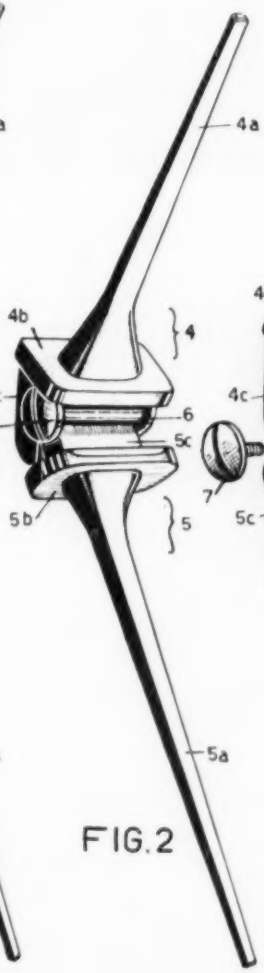

FIG. 2

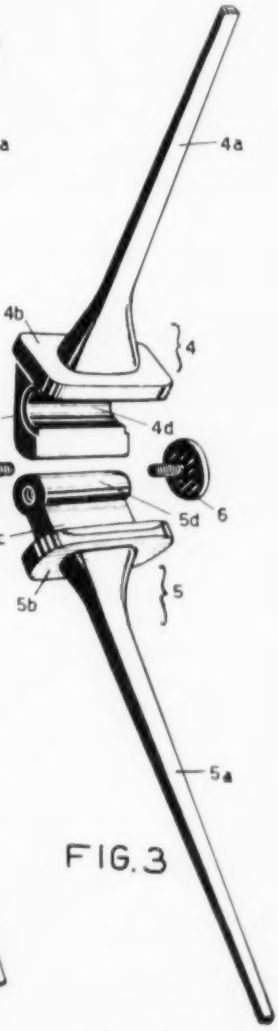

FIG. 3

* Chief: Prof. J. F. Nuboer, M.D.

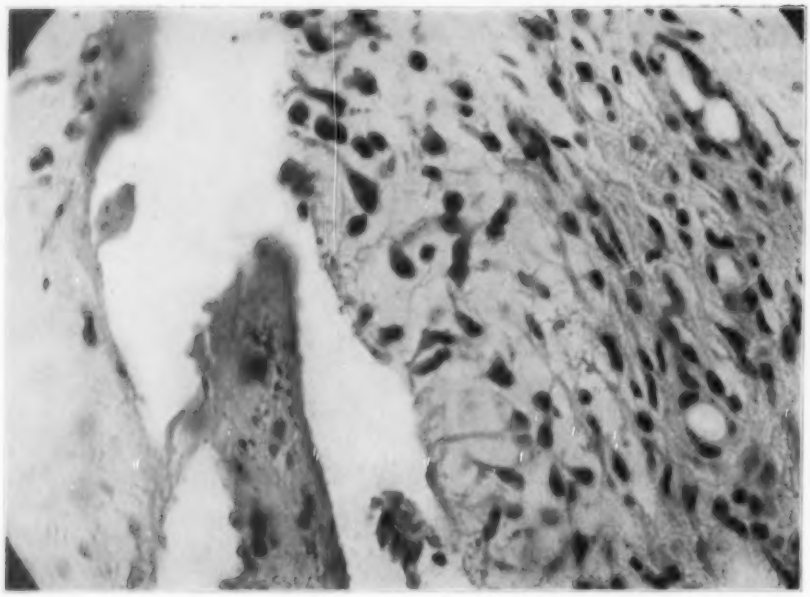

FIG. 4

Dog 2. Photomicrograph (× 45). On the right a section of synovial membrane is shown. On the borderline of this there is necrosis and on the extreme right there is metaplasia. There is some pigmentation.

As early as 1827 an attempt was made to restore mobility to a hip joint by an osteotomy.[1] In 1860 Verneuil proposed the interposition method. For this Helferich used a pedicled muscle flap. Murphy used a pedicled fascia-and-fat flap for the knee, while Payr obtained good results with transplantation of free fascia.

Various types of foreign bodies have been used for the same purpose: prepared bladders of pigs, magnesium, silver and gold leaf, fascia impregnated with silver, hernial sacs, and amnion hardened in formalin. Lexer made use of impregnation with wax as a substitute for cartilage. The results from the use of *corpora aliena* as interposition material were, on the whole, less satisfactory than those following the use of vital material. All of these materials except gold act as strong irritants on the adjacent tissues. Besides the gold used formerly we now have at our disposal stainless steel, tantalum, Vitallium, plastics, and artificial resins. With these materials new attempts at arthroplasty have been made. In 1939 Smith-Petersen described the interposition method with Vitallium for the hip joint. In 1946 Judet and Judet used a plastic replacement for the femoral head. Kuhns and Potter in 1950 used plastic as interposition material in a knee arthroplasty, while in 1951 Diamant-Berger described an acrylic prosthesis for the knee joint. In Holland, Boerema experimented with a metal elbow, but no definite results are known.

Artificial metal joints were, therefore, not considered very promising. Küntscher, with his large experience in the field of stainless steel, experimented with metal joints, but without success. He rejected joint alloplasty for the reason that metal parts gliding over one another would always give rise to such corrosion as to loosen the prosthesis. This opinion, however, is not shared by the writer.

The fact that a search of the literature failed to reveal any record of successful metal alloplasty is due to the technical difficulties of the procedure. These may be divided into three groups: (1) the composition of the metal; (2) the architecture of the joint to be constructed; and (3) the insertion of this joint. It was believed that the joint should be made of metal, since in metal with the proper composition corrosion is slight. SMo 18–8

stainless steel was used, since the characteristics of this metal when it is implanted in the dog are now sufficiently well known. It was possible to test the quality of the metal used in a prosthesis which had remained in an experimental animal for as long as seven months and was afterward tested extensively by the manufacturers. From this it appeared that no structural changes had occurred. The main inconvenience of a metal prosthesis is its weight. This can be avoided by casting the joint hollow.

In constructing articular prostheses we first turned our attention to the knee, as this seemed the easiest joint to construct. Pressure forces are always present and the prosthesis can be easily inserted. In reality the knee joint is a complicated one; we simplified it by attending only to the hinge action. The hinge joint, however, has the disadvantage of having little stability during weight-bearing. As we considered perfect stability to be an important requirement, we made a fast-joint hinge. The attachment of the joint to the adjacent bones should be as firm as possible—that is, the surface of contact and friction between metal and bone should be as large as possible. Practically this is approximated by intramedullary-pin fixation, in which the pin must be as thick and as long as possible.

Our joint consists of four separate parts. One part is inserted into the femur and another into the tibia. Both parts are then introduced into each other and two screws in the tibial piece are tightened to prevent their gliding apart. In the femoral part space has been allowed for the heads of the screws, so that unrestricted motion is possible. The femoral part also allows for sliding of the patella and the tibial part was constructed to allow for the ligamentum patellae (Figs. 1, 2, and 3).

The knee of the dog offers special difficulties in contrast with the knee of man. In the dog the knee is always in the valgus position; extension to 180 degrees is not possible and weight-bearing takes place with the knee in the bent position. The latter characteristic especially makes great mechanical demands on an alloplastic joint. It was therefore decided to limit extension and flexion from 150 to 60 degrees. In the human subject the mechanical relationships are more simple and there is therefore less mechanical stress on the prosthesis. Moreover, in human patients the chances for success are greater because of psychological factors.

The articulating part of the prosthesis has been constructed in such a way that interposition of soft parts is almost impossible. For insertion of the prosthesis the knee joint is widely opened according to the method described by Payr. The ligamentum patellae and the patella are both reflected medially. After the fibular collateral ligament has been cut, the menisci and the cruciate ligaments are removed. The tissues of the popliteal space remain intact. The femoral condyles are cut off almost perpendicularly to the axis of the bone and the medullary cavity is opened. From the tibial condyle only 0.75 centimeter of cartilage, together with the adjoining bone, is removed, while the tuberosity of the tibia with the ligamentum patellae is saved. After both medullary cavities have been opened, the femoral and tibial parts of the prosthesis are inserted deeply enough so that the metal collar rests on the cortex. After the two parts have been connected, both screws are applied and tightened. The patella is replaced and the wound is closed in layers. The extremity is not immobilized.

According to our experience, the success of the experiment is dependent upon proper dimensions of the prosthesis; the artificial joint can still function if it is too small, but it must not be too large. Thus the prosthesis should be individually fitted, but after several experiments it was concluded that three or four standard models would be sufficient, provided the medullary pins were long enough.

Three experiments were performed. One dog died from distemper ten days after operation; in the second the prosthesis was too large and the pins were not long enough. The function of this joint was poor, so that after seven months the prosthesis was taken out. The microscopic findings in sections from the joint capsule from this dog may be summarized as follows: The joint capsule showed the type of alteration usually found in

FIG. 5-A FIG. 5-B FIG. 5-C FIG. 5-D

Fig. 5-A: Dog 3. Roentgenogram made three months after operation.
Fig. 5-B: Roentgenogram made six months after operation.
Fig. 5-C: Roentgenogram made one year after operation.
Fig. 5-D: Roentgenogram made three years after operation shows a good result.

rigid fibrous tissue; there were a large number of wide capillary vessels; perivascular cells had multiplied, a feature similar to angioma; these areas were encrusted with iron pigment. It was also apparent that there was metaplasia of the collagenous connective tissue in the fibrous cartilage (Fig. 4).

The third dog has had the longest follow-up, a period of over three years. As early as two months after the operation the animal used its extremity again in such a way that it would not have been possible to tell the difference between the experimental and the control limb.*

The roentgenograms have been of particular interest. At three months and at six months the experiment threatened to become a failure because of decalcification (Figs. 5-A and 5-B). At twelve months, however, the bone process had stabilized. The prosthesis was lined with a zone of bone resorption and of osteosclerosis, while the cortical weight-bearing surfaces had broadened (Fig. 5-C). Bone resorption and sclerosis are normal findings in intramedullary pinning. At first there is a zone of resorption around the pin, which is a result of pressure. If fixation is not complete, the pressure exerted by the pin on the surrounding bone tissue increases and results in more bone resorption. Normally, the surrounding bone tissue reacts by forming a layer of osteosclerosis. It was possible to confirm this histologically in the second dog. If the quality of the metal and the fixation of the prosthesis are ideal, there is only minimal resorption and at a later stage the pin is surrounded by a thin layer of connective tissue.

The prosthesis shown in the x-rays was not ideal, as the medullary pin in the tibia was too short. In spite of this, good clinical and roentgenographic results were obtained.

NOTE: Grateful acknowledgment is made to Dr. B. den Hartog, Department of Pathology, St. Elisabeth Hospital, Tilburg, Holland, for his analysis of the microscopic sections.

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* A motion picture of this dog was shown at the International Congress for Surgery in Paris, 1951. The follow-up has now been four and a half years and function is excellent. Another dog has been followed for three-quarters of a year and has good function.

ACRYLIC PROSTHESIS REPLACING LOWER END OF THE FEMUR FOR BENIGN GIANT-CELL TUMOR

BY GEORGE L. KRAFT, M.D., NORTH HOLLYWOOD, AND
DANIEL H. LEVINTHAL, M.D., BEVERLY HILLS, CALIFORNIA

In 1949 the authors described the various methods of treatment of benign giant-cell tumors and emphasized the surgical reconstruction of bones after eradication of these tumors. When the distal end of the femur was involved and its articular surfaces were intact, the tumor tissue was removed and was replaced by massive bone grafts and multiple bone chips. When the distal end of the femur and the articular surfaces were destroyed by the tumor mass, strut grafts were placed from the femur into the head of the tibia, so that an arthrodesis was produced. In extensive lesions with fracture of the femur and massive destruction, amputation was the method of choice. With the advent of acrylic and metal prostheses, starting with the work of Moore and Bohlman, and in recent years the extensive work of Judet and Judet, MacAusland, and others [2,6,7], replacement of the proximal end of the femur, the proximal end of the humerus, the distal end of the humerus, the head of the radius, and other bones has entered a new era.

So far as the authors can determine, no attempt has been described in the literature at replacement of the distal end of the femur by an acrylic prosthesis, after resection of an extensive benign giant-cell tumor with a pathological fracture. Such a case history is presented herewith.

Mrs. M. L., aged thirty-seven years, first came to the authors' attention on November 7, 1951, after she had sustained a pathological supracondylar fracture of the right femur through a large tumor mass. She stated that since February 1951 she had been aware of pain in the right knee associated with enlarge-

FIG. 1-A

FIG. 1-B

Fig. 1-A: Benign giant-cell tumor of the right femur, extending down to the cortical bone of the articulation and showing a pathological fracture.
Fig. 1-B: Roentgenogram of normal left femur for comparison and measurements.

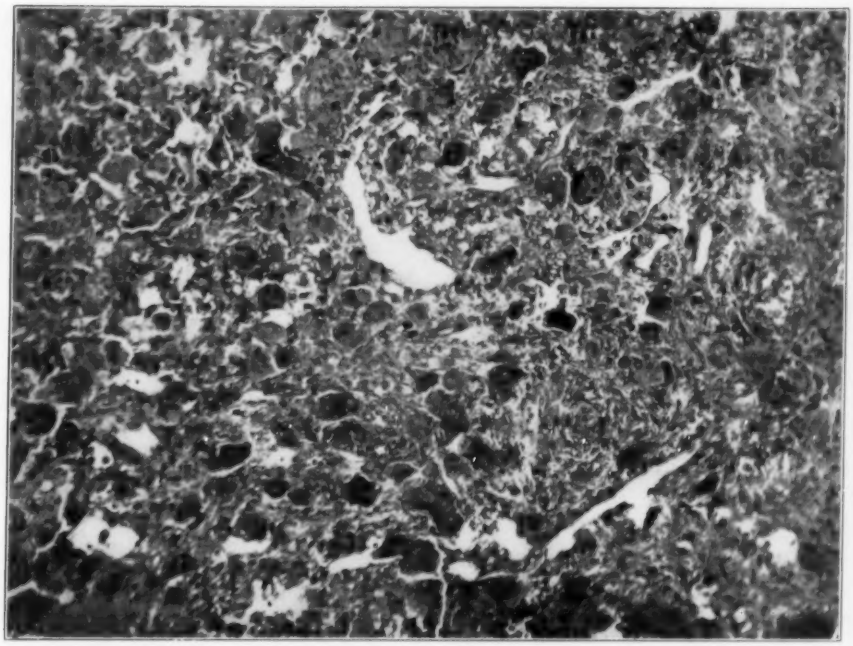

FIG. 2

Photomicrograph (× 11) showing typical giant-cell tumor, Grade II.

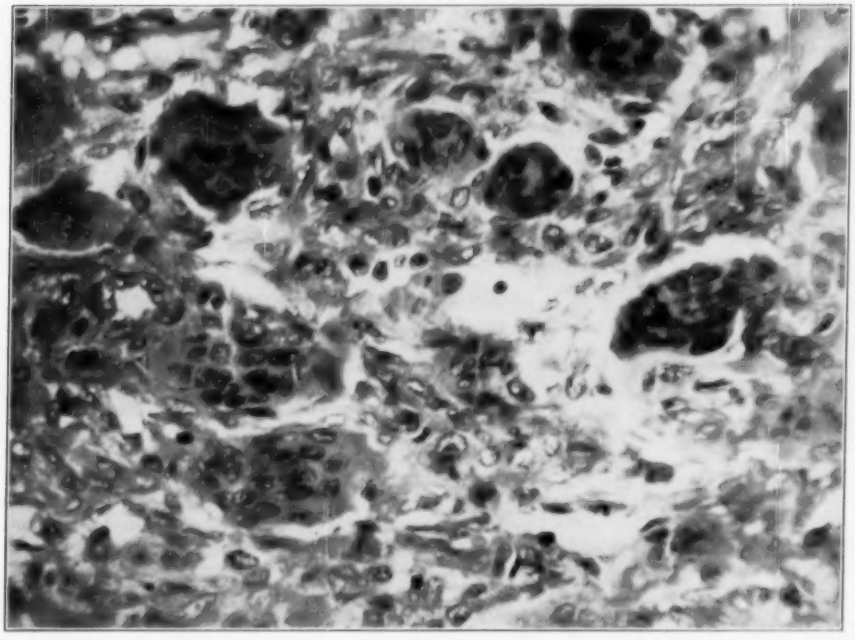

FIG. 3

Photomicrograph (× 100) showing character of giant cells.

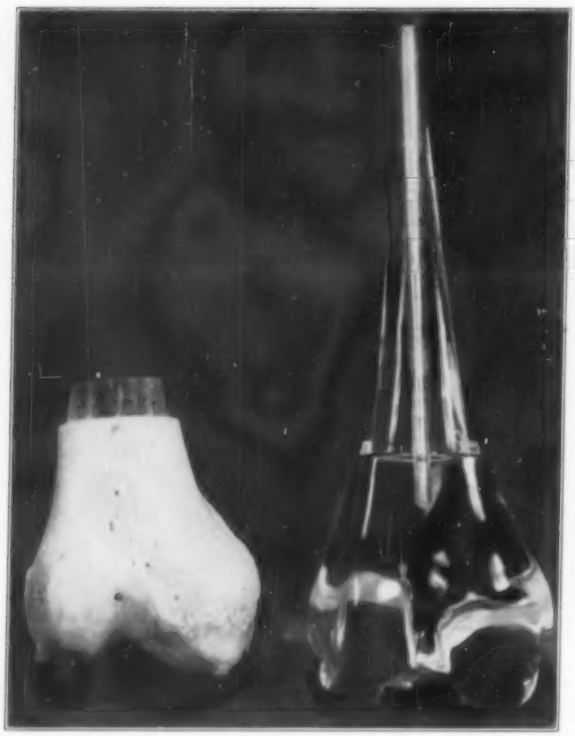

FIG. 4

FIG. 5

Fig. 4: Distal end of a femur of approximately the same size as the patient's femur was used as a model for the acrylic prosthesis. The stainless-steel insert was later found not to be necessary.

Fig. 5: The acrylic prosthesis inserted into position in the model femur, revealing how the femur rests on the platform of the prosthesis. Note the lock-and-key arrangement which prevents rotation.

ment and marked local tenderness. This became progressively more disabling until the pathological fracture occurred. Roentgenograms made on November 7, 1951 (Fig. 1-A), revealed an osteolytic lesion of the distal end of the right femur with marked thinning of the cortex and a supracondylar fracture through the tumor mass. A biopsy was done on November 8, 1951, and the tissue was described as a Grade II giant-cell tumor (Fig. 2).

A roentgenogram was made of the left femur and, after its true measurements had been determined, an anatomical specimen of a right femur of the same size was obtained. This was used as a model to hand-carve a prosthesis (Fig. 4), which was to be used as a replacement for the bone defect after excision of the tumor mass. The weight-bearing end of the femur was to rest on the flange or platform of the prosthesis (Fig. 5).

Since the stress and strain of weight-bearing is in the direct axis of the femur, this is both mechanically correct and physiologically proper as far as the living bone stress is concerned. The lock-and-key arrangement between the prosthesis and the femur was to prevent rotation. The stainless-steel rod incorporated into the prosthesis was later found to be unnecessary, as will be reported. Acrylic was preferred to any other substance, because it is exceptionally light in weight; it is an inert substance when placed within the body; it is durable; it has an inherent flexibility which makes its use more physiological; and it is adaptable to reshaping, if necessary, during the surgical procedure.

The patient was subjected to surgery on December 11, 1951. A medial parapatellar incision was made and the capsule of the joint was incised, the knee joint being exposed. The shaft of the femur was exposed through the suprapatellar pouch and the supracondylar fracture, which showed a moderate amount of callus formation, was revealed. With a Gigli saw, the shaft of the femur was cut at a predetermined level where the bone appeared to be normal. The distal, diseased end of the femur was removed extraperiosteally, in such a manner that the continuity of all of the tissues, including the ligaments, was not disturbed. (This was a very important factor in maintaining the stability of the knee after operation.) The cancellous bone of the condyles was found to be completely replaced by tumor tissue. The cortex was extremely thin, the posterior wall being completely replaced by tumor. After a thorough surgical excision, washing with saline

FIG. 6-A FIG. 6-B

Figs. 6-A and 6-B: Roentgenograms made January 8, 1952, approximately one month after operation.

Fig. 7: Composite photograph showing range of motion five months postoperatively — 55 degrees.

solution, and aspiration, the extensive space created after excision of the tumor was found to be thoroughly clean. A cross slot was made in the stump of the femur to receive the key of the prosthesis, the fit being perfect. The wound was closed by layers in the routine manner, and a circular cast was applied snugly from the toes to the groin.

Immediately after surgery the patient's pain was completely gone. She was encouraged to do quadriceps-setting exercises while the extremity was encased in the cylinder cast.

FIG. 7

On January 8, 1952, a little over four weeks after the operation, the cast was removed and roentgenograms were made (Figs. 6-A and 6-B). A new cast was then applied from the ankle to the groin. The patient was permitted to bear weight and did so without any discomfort.

On February 15, 1952, approximately nine weeks after the operation, the cast was removed, and active and passive knee exercises were started to increase motion of the joint. The stability of the knee was found to be excellent, and there was no pain with motion. The patella moved in the prepared patellar groove of the prosthesis with a smooth gliding motion. The patient had an uneventful convalescence, so that by May 1952 she had 55 degrees of active painless motion in the right knee (Fig. 7). There was shortening of the right extremity of 0.9 centimeter, which was corrected by a lift in the heel. The patient was active in every respect, being able to drive her car, go shopping, do her housework, and even dance.

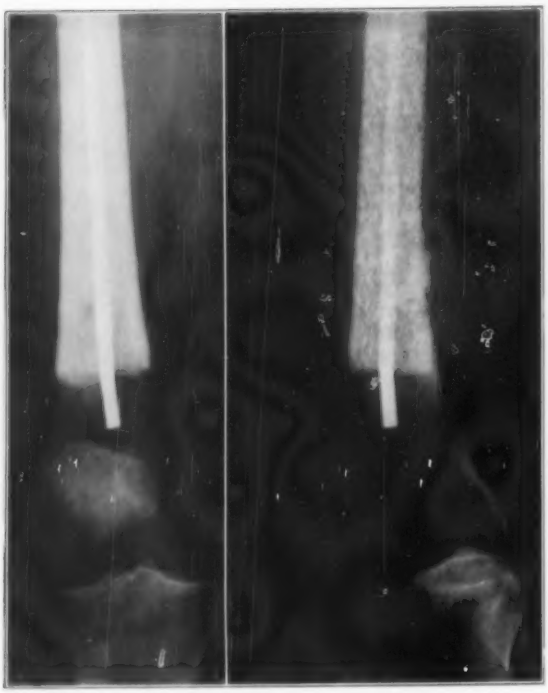

FIG. 8-A

FIG. 8-B

(See page 373)

FIG. 9

(See page 373)

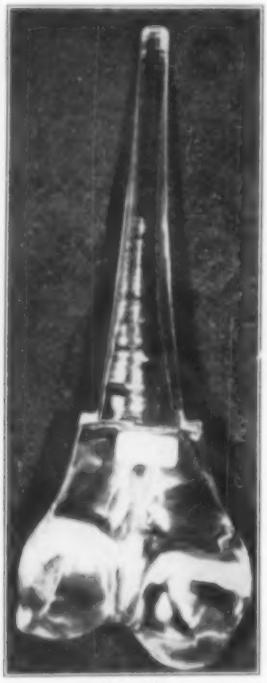

FIG. 10

(See page 373)

FIG. 11-A

FIG. 11-B

(See page 373)

Figs. 8-A and 8-B: Roentgenograms made September 25, 1952, reveal stainless-steel insert to be slightly bent at its distal end, indicating that the prosthesis had fractured at that point.

Fig. 9: View of fractured prosthesis.

Fig. 10: The new prosthesis, with the sharp angles at the flange and notches eliminated. Note the absence of the stainless-steel insert.

Figs. 11-A and 11-B: Roentgenograms made after insertion of the new prosthesis.

FIG. 12

FIG. 13

Fig. 12: Composite photograph showing the range of motion—47 degrees—three months after insertion of the new prosthesis.

Fig. 13: Photograph taken three months after insertion of the new prosthesis. The side view reveals slightly limited extension of the right knee.

In the latter part of September 1952, the patient reported by telephone that, while she was drying dishes, she had heard a snap in her right knee, associated with pain. In addition, she was unable fully to extend her right knee. A roentgenogram was made on September 25, and the stainless-steel rod within the prosthesis was found to be slightly bent (Figs. 8-A and 8-B). This indicated that the prosthesis had broken.

Structural engineers were consulted to determine the cause of the break in our prosthesis. They gave the following explanation: When the prosthesis was made, the angle between the tongue and the platform, as well as between the key notch and the tongue, was made too sharp, creating a structural weakness which was bound to result in a fatigue fracture; this was likened to a circular scratch made on the neck of an ampule. It was also felt that the stainless-steel insert did not add to the strength of the prosthesis. In the construction of a new prosthesis, these errors were corrected.

The patient was again subjected to surgery on October 28, 1952. Under tourniquet, an incision was made through the old scar and through the capsule, and the joint was exposed. The acrylic prosthesis was found to be fractured one-half inch proximal to the base of the flange (Fig. 9). The prosthesis was removed with ease; the cartilaginous surface of the tibia and the patella had a normal appearance; and the synovial tissue of the joint appeared normal. The weight-bearing end of the femur was covered with fibroplastic tissue. The new prosthesis (Fig. 10) was inserted, and the wound was closed by layers in the routine manner. A cylinder cast was applied from the groin to the ankle. The patient was allowed to be ambulatory after one week, and the cast was removed on November 17, 1952. The last roentgenograms (Figs. 11-A and 11-B) made on December 15, 1952, revealed no bone reaction.

When she was seen on May 1, 1953, the patient had no complaints. She was as active as she had been before the fracture of the first prosthesis. Her range of motion was 47 degrees (Fig. 12) and she had slight flexion of the knee in standing (Fig. 13).

COMMENT

While there have been many reports, especially in recent years, of replacement of diseased or useless portions of bones by metal or acrylic appliances, so far as we can determine this is the first time that the lower end of the femur has been replaced with a prosthetic appliance made of pure acrylic. The satisfactory result so far is most encouraging and gives

promise of opening a new phase in reconstructive surgery of the skeleton, particularly of the lower extremities, in which new weight-bearing joints can function satisfactorily with adequate motion and without pain.

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DISCUSSION

Tuberculosis of the Spine

(*Continued from page 240*)

Bed rest for three months in adults and for six months in children seems insufficient. A year for each has given much better results. True, ankylosis may exist at the earlier date, but reabsorption of abscess granulation tissue and development of limiting fibrosis will take much longer.

The fusion must extend far enough to cover the entire bony involvement, seen or unseen. It must not be related to destroyed vertebral segments (one or two above and below) but to the secondary findings of abscess extent and to the presence of mottled shadows in vertebral bodies outside the area of obvious destruction.

There are several points we would emphasize about the complication of paraplegia. It can frequently be prevented in the incipient stage by gentleness in dissection and by avoiding decortication from chisel and mallet percussion. Usually, as the authors state, it is due to extradural compression from abscess or granulation tissue. It may, however, be due to direct pressure of bony fragments caught and pressed backward between the inclined planes of adjacent vertebral bodies. In neither case is laminectomy indicated. When paraplegia is due to abscess pressure, a spine fusion, if secure, will offer the best chance of arrest of the disease and recession of pressure. When fragments are causing the compression, laminectomy cannot provide access for their removal. Fusion must first be secured for support; later the anterior decompression may be begun.

We found at Sea View Hospital that, of fourteen consecutive patients admitted with paraplegia and on whom previous laminectomies had been done, all died except four, upon whom circumduction fusion was later performed.

Diseased bodies can be and are held apart if fusion becomes solid and if sufficient bone is used, that is, iliac-strip reinforcement. We have found this to be true in adults, even in a patient with five and one-half vertebral bodies destroyed, and in children, in whom the healing ossification builds across the uncollapsed vertebral bodies.

Collapse occurs with pseudarthrosis, an insufficient period of recumbency, or too little mass of bone-graft material.

It has been a pleasure to be permitted to discuss this most interesting paper.

THE IMPORTANCE OF BONE GROWTH AS A FACTOR IN THE REDISTRIBUTION OF BONE SALT

I. Redistribution of Radio-Active Calcium in the Skeleton of Rats

BY GÖRAN C. H. BAUER, MALMÖ, SWEDEN

*From the Orthopaedic Clinic *, Malmö, and the Pharmacological Institute ** of the University of Lund, Lund*

"Because of the rapid exchange of calcium between bone and body fluids, the uptake of Ca^{45} by the skeleton following its administration to the animal cannot be used as a measure of new bone salt deposition."

This statement appears in the paper by Harrison and Harrison, which describes a series of experiments on the accumulation of radio-active calcium (Ca^{45}) in the skeleton of young rats. The rats were killed at intervals ranging from two hours to two weeks after the administration of radio-active calcium.

Harrison and Harrison base their statement partly on the assumption that the ratios of the specific activities of the calcium of the epiphyseal ends of the long bones to the specific activities of calcium of the diaphyseal portions of these bones gradually approach unity. The authors believe that, when this ratio has reached unity, the specific activity of calcium is uniform throughout the entire skeleton and is equal to that of the interstitial body fluid,— that is, a state of equilibrium has been reached.

If, however, an equilibrium had been reached, these ratios would not only approach unity but would also *remain at this level.*

In the paper by Harrison and Harrison, it is stated that the ratios of the specific activities of the calcium of the epiphyseal portions of the long bones to the specific activities of the calcium of the diaphyseal portions of the long bones were near unity two weeks after the administration of radio-active calcium, this being the longest time interval studied by the authors. If, however, the authors' values are plotted with time as the base and the diaphyseal to epiphyseal ratio of the specific activities of calcium as the ordinate (Chart I), it will appear that the curve obtained approaches the level of unity at a wide angle. If this curve crossed the level of unity at longer time intervals, it would mean that the different specific activities of calcium do not stay equal and that no true equilibrium would have been reached during the period of the investigation referred to.

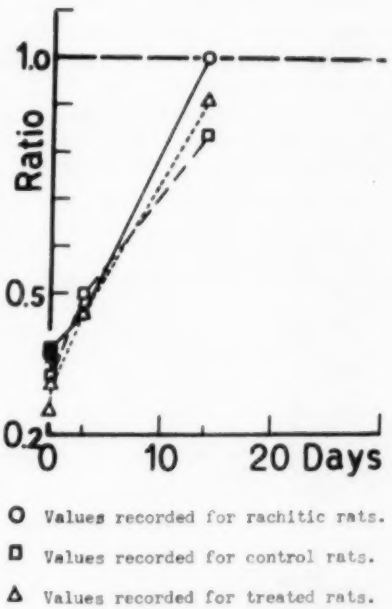


CHART I

Ratio of the specific activity of the diaphyses to that of the epiphyses at varying time intervals after the administration of radio-active calcium (Ca^{45}) to young rats. This chart was composed from values derived from the work of Harrison and Harrison.

The following experiment was made in order to investigate whether or not an equilibrium is established as regards radio-active calcium in the skeleton of rats.

* Chief: S. von Rosen, M.D.
** Chief: G. Ahlgren, M.D.

TABLE I-A

ASH-WEIGHT VALUES OF THE DIFFERENT SAMPLES OF BONE (HUMERUS) AT VARYING TIME INTERVALS AFTER THE ADMINISTRATION OF RADIO-ACTIVE CALCIUM (Ca^{45}) TO YOUNG RATS

Time after Administration of Ca^{45}	No. of Animals	Average Weight of Animals in the Respective Groups (*Grams*)	Ash Weight in Milligrams of the Bone Samples †					Average Length of the Humerus (*Millimeters*)
			Piece 1	Piece 2	Piece 3	Piece 4	Piece 5	
18 hours	5	60	56	119 *		64 *		18.6
3 days	4	68	53	52	56	42	34	19.1
11 days	5	96	81	71	89	68	59	20.0
18 days	4	93	63	58	66	57	54	20.4
31 days	5	114	108	110	122	62	74	20.7
67 days	4	172	114	105	123	124	104	24.2

† The ash was weighed with an accuracy of ± 0.5 milligram.

* The 18-hour bone samples were pooled so that Pieces 2 and 3 formed one sample and Pieces 4 and 5 formed one sample.

EXPERIMENT

Twenty-seven rats of mixed strain were given about twenty milligrams of low specific-activity radio-active calcium (Ca^{45}) in the form of an aqueous solution of lactate by means of a stomach tube. The rats had received a normal diet after being weaned and weighed about sixty grams when the radio-active calcium was administered. The rats were then about six weeks old. They were killed in groups of four or five with an overdose of ether at varying time intervals after the administration of the radio-active calcium.

Each humerus, femur, and tibia was dissected free from muscle immediately after the death of the animals and was cut into five parts by means of a concentric double-blade saw. The distance between the saw blades was about five millimeters, and each blade was 0.1 millimeter thick.

The first piece from each bone was cut with the saw blades placed at equal distances from the middle of the bone. The next piece formed the five millimeters proximal to the first or central piece, and the third piece formed the five millimeters distal to the central piece. The proximal remainder of the bone formed the fourth piece and the distal remainder of the bone formed the fifth piece (Fig. 1).

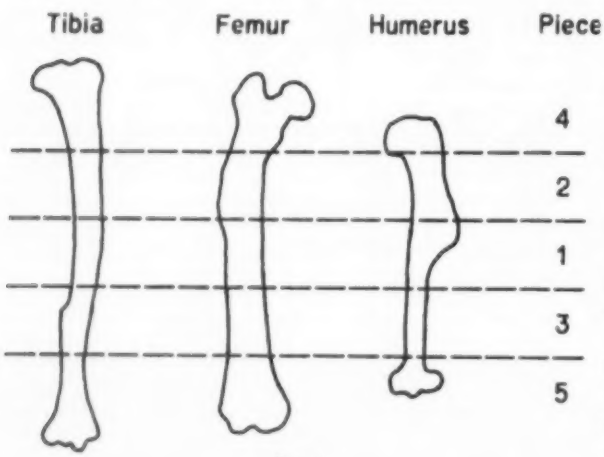


FIG. 1

Each femur, tibia, and humerus was cut into five pieces. The pieces from each bone were numbered as shown in the drawing.

In this way, one diaphyseal and two epiphyseal pieces of bone were obtained from each bone. The second and third pieces were so situated that they included both kinds of bone.

In each group of animals, all of the pieces of the humeri with the same number were pooled to form one sample; the same was done with the pieces of bone obtained from the femora and the tibiae. Fifteen samples of bone were thus obtained from each group of animals.

The bone samples were ashed[1], and the bone ash was

TABLE I-B

ACTIVITY VALUES OF THE DIFFERENT SAMPLES OF BONE (HUMERUS) AT VARYING TIME INTERVALS AFTER THE ADMINISTRATION OF RADIO-ACTIVE CALCIUM (Ca^{45}) TO YOUNG RATS

Time after Administration of Ca^{45}	No. of Animals	Average Weight of Animals in the Respective Groups (*Grams*)	Activity (in Counts per Second) of the Bone Samples †				
			Piece 1	Piece 2	Piece 3	Piece 4	Piece 5
18 hours	5	60	15.9	14.9 *		12.4 *	
3 days	4	68	11.4	23.9 **	9.4 **	20.4 **	11.4 **
11 days	5	96	11.6	17.6	10.6	9.6	8.8
18 days	4	93	14.4	18.4	11.0	13.5	15.7
31 days	5	114	30.8	22.8	27.3	15.6	21.8
67 days	4	172	13.4	6.0	13.1	8.6	11.9

† The radio-activity of the bone samples was measured on nitric-acid solution of the ash. The estimated error of these measurements is less than ±3 per cent. The volume of the solutions was 3.5 milliliters, except for those marked * which were 15 milliliters and those marked ** which were 5 milliliters.

The 18-hour bone samples were pooled, so that Pieces 2 and 3 formed one sample and Pieces 4 and 5 formed one sample. Fig. 1 shows the manner in which the bones were cut and the pieces were numbered.

weighed and was dissolved in nitric acid (Table I-A). For measurements of radio-activity of the bone solutions[1], an E. K. Cole ratemeter, type 1037A2[19], was employed with a lead-shielded mica end-window Geiger-Mueller tube (Tracerlab, type TGC 2). The background determinations were made with an additional direct high-speed mechanical register (Tracerlab SC-17). The background encountered with this device was about 0.7 counts per second. Counting rates below 10 counts per second were determined with a CR (capacitor-resistor) constant of 160 seconds and above 10 counts per second with a CR constant of 40 seconds. At least two independent readings were always taken for each sample. No counting rates higher than 60 counts per second were accepted. The standard deviation of the radio-activity values arrived at in this manner was less than 3 per cent. (Table I-B).

RESULTS

The specific activities of the calcium of the different bone samples were determined. In Table II are listed the ratios between these values of the central portions (pieces numbered 1) of the diaphyses of the humeri, the tibiae, and the femora of each group and the corresponding values of the other four portions of the same bones.

In Chart II the figures gained from the femur are plotted on exactly the same scale as the one used when plotting the figures derived from Harrison and Harrison. It is obvious that the ratios of the specific activities of calcium between the central and the other portions of the same bone rise from an initial value below the level of unity to a value above this level. Most of the ratios recorded show a continuous rise, and even over the longest time interval (sixty-seven days) only a few of these ratios show any tendency to decline.

The curve derived from the specific-activity ratio of calcium of the proximal end of the tibia starts from a lower initial value and ends at a higher value than the curve obtained from the specific-activity ratio of the distal end of the same bone. On the other hand, the curve plotted from values derived from the distal end of the femur has a sharper inclination than the curve plotted from values derived from the proximal end of the same bone.

DISCUSSION

The present investigation shows that the distribution of radio-active calcium in the skeleton does not reach equilibrium during the period of sixty-seven days after the administration of the radio-active calcium to young rats. The rats which were used were of approximately the same age and weight as those used by Harrison and Harrison. The

TABLE II

RATIOS OF THE SPECIFIC ACTIVITIES OF CALCIUM OF THE CENTRAL PORTIONS OF THE DIAPHYSES TO THOSE OF THE OTHER FOUR PORTIONS OF THE FEMORA, TIBIAE, AND HUMERI AT VARYING TIME INTERVALS AFTER THE ADMINISTRATION OF RADIO-ACTIVE CALCIUM (Ca^{45}) TO YOUNG RATS †

	Time after Administration of Ca^{45}	Ratio of Specific Activity of Piece 1 * to That of			
		Piece 2	Piece 3	Piece 4	Piece 5
Femur	18 hours **	0.64		0.34	
	3 days	0.80	0.55	0.48	0.34
	11 days	0.84	0.71	0.83	0.92
	18 days	0.85	0.64	0.82	0.96
	31 days	1.02	0.91	0.96	1.24
	67 days	1.12	1.68	1.45	1.86
Tibia	18 hours **	0.69		0.24	
	3 days	0.56	1.05	0.20	0.65
	11 days	0.57	0.96	0.62	0.71
	18 days	0.57	0.98	0.70	0.77
	31 days	0.64	1.05	0.99	0.79
	67 days	1.04	1.30	1.93	0.92
Humerus	18 hours **	0.52		0.34	
	3 days	0.32	0.89	0.31	0.44
	11 days	0.58	1.20	1.04	0.96
	18 days	0.73	1.38	0.97	0.79
	31 days	1.36	1.26	1.12	0.96
	67 days	2.10	1.10	1.70	1.03

† The values in this table are footed on activity measurements with a standard deviation of less than ±3 per cent. and a weighing error of less than 1.5 per cent. of the ash weights.

* Consult Fig. 1 for an explanation of the manner in which the bones were cut and were numbered.

** The eighteen-hour bone samples were pooled, so that Pieces 2 and 3 formed one sample and Pieces 4 and 5 formed one sample.

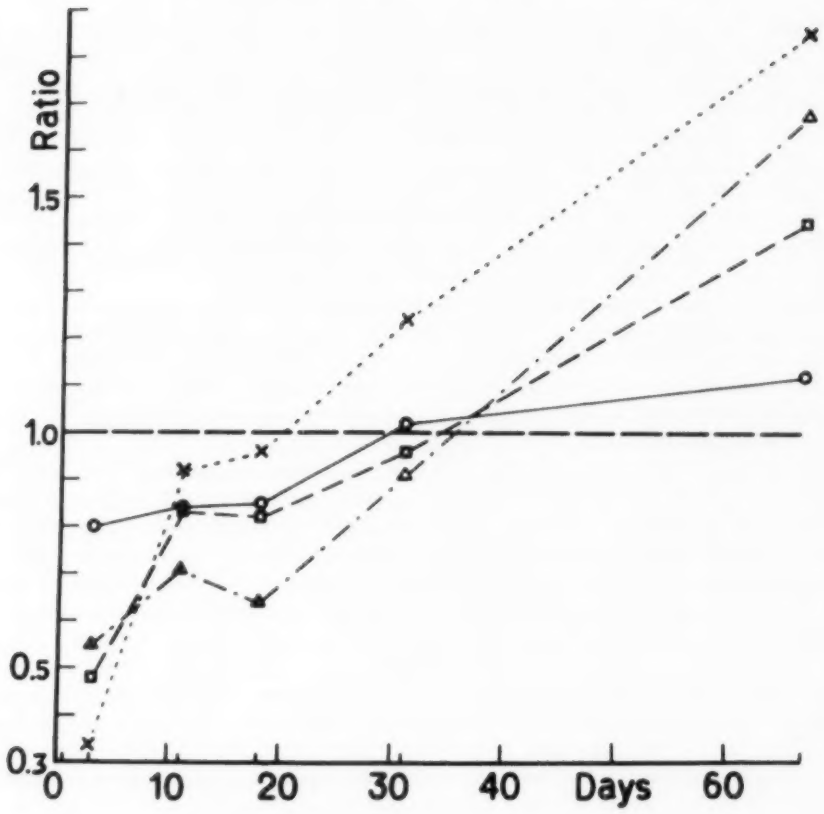
initial fourteen-day period of the author's investigation covers the period of time (after the administration of radio-active calcium) which was investigated by Harrison and Harrison, and the curves derived from the author's experimental work have the same general course as the curves obtained for the corresponding ratios in their experiment. It seems, therefore, that Harrison and Harrison misinterpreted their data when they believed that an equilibrium was reached as regards the distribution of radio-active calcium fourteen days after its administration.

Duckworth and Hill, in 1953, quoted Harrison and Harrison's statement that in young rats half of the total skeletal calcium had exchanged with body fluid in forty-five hours. (This conclusion is based on the experiment previously criticized in this paper.)

Carlsson, in 1951, pointed out that Harrison and Harrison's conclusion is founded on the assumption that a major part of the bone-salt crystals formed during the experiment was rapidly dissolved. As there is no support for that assumption, Carlsson objected to their conclusion. The present investigation shows this objection to be valid.

Carlsson, in 1951 and 1952, had shown that in young rats the skeletal distribution of orally administered radio-active calcium (Ca^{45}) is closely related to the growth and calcification of the different parts of the skeleton.

Comar and his associates, in 1952, administered radio-active calcium (Ca^{45}) to young pigs in a radio-autographic study. A short time after administration, an image of radio-active calcium (Ca^{45}) laid down subperiosteally in the compact bone of the diaphysis of the femur was clearly visible. At that time the metaphyseal area was outlined in black in the radio-autograms. Sixty days later an image of radio-active calcium could still be seen in the diaphysis. At that time there was practically no image of the radio-active calcium of the newly formed bone. This must mean that no equilibrium exists between body fluids and a considerable part of the diaphyseal bone.



○ Ratio of specific activity of Piece 1 to that of Piece 2.

△ Ratio of specific activity of Piece 1 to that of Piece 3.

□ Ratio of specific activity of Piece 1 to that of Piece 4.

× Ratio of specific activity of Piece 1 to that of Piece 5.

CHART II

Ratios of the specific activity of the calcium of the central portion of the femur to that of the other four portions of the same bone at varying time intervals after the administration of radio-active calcium (Ca^{45}) to young rats. This chart was composed from the values recorded for the femur in Table II.

It is well known that the growth of the tibia occurs mainly in the proximal end of the bone and that the growth of the femur occurs mainly in the distal end of the bone. The author's values show that, as time passes after the administration of radio-active calcium, the specific activity of the calcium of the proximal end of the tibia becomes lower than that of the distal end of the same bone. In the femur, the distal end acquires a lower specific activity of the calcium than the proximal end. (The specific activities of the calcium of the end portions of the bones are inversely proportional to the ratios recorded in Table II.)

This experiment thus shows that, as the period of time after the administration of radio-active calcium lengthens, the specific activity of the calcium of the end in which the main growth occurs becomes lower than that of the other end of the same bone.

This observation corresponds with the opinion of Carlsson that the areas of most active bone growth lose activity to areas of slower bone growth.

Singer and Armstrong, in 1951, stated that the specific activities of calcium of different parts of the skeleton of big rats differ soon after the administration of radio-active calcium and decrease to a common value after fifty-two days, following which the specific activities decline at equal rates. Thus, before Day 52, the ratio of the specific activity of calcium of the diaphyses to the specific activity of the epiphyses rises from a value below unity. From their Figure 1, however, it is obvious that during the time interval from about fifty to 180 days after the administration of the radio-active calcium the specific activity of calcium of the diaphyses is higher than that of the epiphyses.

The ratio of the specific activity of calcium of the diaphyses to that of the epiphyses thus rose from a value below unity to a value above unity.

Singer and his coworkers, in 1952, made a similar experiment with non-growing rats "in order to eliminate the influence of skeletal growth on the results". It seems, however, that the distal epiphyses of the femur of the rat will never fuse and that the longitudinal growth will never cease[4]. In their investigation, the ratio of the specific activity of calcium of the diaphyses to that of the epiphyses of femora rose from 0.38 to 0.75 during the 210 days of the experiment.

When the values represented by the author's curves are compared with the values derived from the two investigations made by Singer and Armstrong and Singer and his coworkers, it appears that the ratio of the specific activity of calcium of the diaphyses to that of the epiphyses rose with time in all of the three experiments. There is a difference only in the inclination of the curves. The level of unity is crossed at an interval of time after the administration of radio-active calcium which varies inversely with the rate of skeletal growth of the animals.

SUMMARY

Young rats were killed at varying time intervals after the administration of radio-active calcium (Ca^{45}). The specific activities of radio-active calcium were determined for various parts of the skeleton.

It was found that the ratio of the specific activities of diaphyseal bone to that of epiphyseal bone rose continually from a value below unity to a value above unity over an interval of as long as sixty-seven days between the administration of the radio-active calcium and the death of the animals.

This means that during this time no state of equilibrium was reached between different parts of the skeleton and body fluid with respect to the distribution of radio-active calcium. It was further shown that the redistribution of radio-active calcium in different parts of the skeleton varied with the rate of growth of these parts.

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THE IMPORTANCE OF BONE GROWTH AS A FACTOR IN THE REDISTRIBUTION OF BONE SALT

II. Redistribution of Radio-Active Phosphorus in the Skeleton of Rats

BY GÖRAN C. H. BAUER, MALMÖ, SWEDEN

From the Orthopaedic Clinic, Malmö, and the Pharmacological Institute** of the University of Lund, Lund*

In the previous study [1], the author followed the redistribution of bone salt for sixty-seven days after the administration of radio-active calcium (Ca^{45}) to young rats. It was concluded that during this time no equilibrium was reached between different parts of the skeleton and body fluid with respect to the specific activity of radio-active calcium.

Using radio-active phosphorus (P^{32}) in young rats, Neuman and Mulryan assumed that such an equilibrium was reached within eighteen days. It would thus seem that the redistribution of bone salt may be interpreted in opposite ways, depending on the isotope chosen for the experiment. However, the experiment of Neuman and Mulryan is open to some criticism. The rats were killed at intervals ranging from two hours to eighteen days after the administration of radio-active phosphorus. The authors found that the specific activity of the phosphorus of the epiphyses during this time gradually approached that of the diaphyses. The two kinds of bone had virtually the same specific activity eighteen days after the administration of radio-active phosphorus, this being the longest time interval studied by the authors.

As was pointed out in the previous paper [1], this would mean that an equilibrium had been established between different parts of the skeleton and, hence, with the body fluid, *only if these specific activities stayed equal.*

The following experiment was made in order to study the redistribution of radio-active phosphorus over a long period of time after the administration of the isotope.

EXPERIMENT

In a series of eighteen young rats, each animal received an injection of about twenty microcuries of radio-active phosphorus (P^{32}) of a high specific activity. The injections were made in the loose subcutaneous tissue of the lumbar region. All of the rats were seven days old and all belonged to three different litters from an inbred strain. After injection, the rats were returned to the cages of their mothers. The rats were weaned when they were four weeks old. They were then kept on a normal diet. The rats were evidently in good health throughout the experiment.

The rats were killed with an overdose of ether in groups of two at time intervals ranging from eighteen hours to fifty-four days after the injection. Their bones were treated in the manner described in the previous paper [1]. However, a pair of razor blades was employed instead of a saw. The distance between the blades was three millimeters and each blade was 0.1 millimeter thick.

The pieces obtained from the tibiae and the humeri were numbered as described in the previous paper [1]. The femora, however, were turned upside down before the different pieces from these bones were cut and numbered (Fig. 1). Pieces 2 and 4 were thus obtained from the distal portions of the femora and from the proximal portions of the tibiae and the humeri. Pieces 3 and 5 were obtained from the proximal portions of the femora and from the distal portions of the tibiae and the humeri. Those pieces which were obtained from the faster-growing ends of the respective bones were thus indicated by the same number.

* Chief: S. von Rosen, M.D.
** Chief: G. Ahlgren, M.D.

TABLE I

SPECIFIC ACTIVITIES OF DIFFERENT PORTIONS OF THE LONG BONES AT VARYING TIME INTERVALS AFTER THE ADMINISTRATION OF RADIO-ACTIVE PHOSPHORUS (P^{32}) TO ONE-WEEK-OLD RATS

No. of Animals	Time after Administration of P^{32}	Average Weight of Animals at Death (*Grams*)	Average Length of Tibia at Death (*Millimeters*)	Specific Activity (Per cent. Dose of P^{32}* per Milligram of Ash)** Piece 1***	Piece 2	Piece 3	Piece 4	Piece 5
2	18 hours	10.4	12.7	0.77	1.22	1.15	1.39	1.50
2	3 days	11.9	14.1	1.18	1.21	1.13	1.42	2.01
2	6 days	11.0	14.8	0.65	0.73	0.69	0.74	0.30
2	11 days	18.5	16.9	0.62	0.54	0.60	0.39	0.43
2	15 days	18.5	17.0	0.54	0.45	0.46	0.28	0.34
2	22 days	36.0	21.3	0.29	0.19	0.28	0.11	0.16
2	32 days	46.0	22.6	0.24	0.11	0.22	0.06	0.11
2	45 days	71.5	23.8	0.13	0.06	0.15	0.03	0.07
2	54 days	82.0	27.0	0.11	0.06	0.13	0.03	0.07

* Allowance has been made for decay. The statistical error of the activity measurements is less than ± 3 per cent.

** From the eleventh day, the weighing error is less than ± 1 per cent. of the ash weights. During earlier intervals this error is greater than ± 1 per cent., the eighteen-hour values being based on a much greater error.

*** Consult Fig. 1 for an explanation of the manner in which the bones were "cut" and the "pieces" were numbered.

Pieces with the same number were pooled at each interval. In this way five bone samples were obtained at each interval. Measurements of ash weight and activity were performed as described in the previous paper [1].

RESULTS

The specific-activity values of the phosphorus per weight unit of ash were determined for the different bone samples. These values are listed in Table I. It appears that fifty-four days after the administration of radio-active phosphorus (P^{32}) to one-week-old rats, the specific activities of different parts of the skeleton were widely different. During this time, the animals increased eightfold in weight, and the bones grew to more than twice their original length. The areas of most active bone growth ultimately attained a lower specific activity than those of slower bone growth.

Chart I shows the ratios of the specific activities of phosphorus of the diaphyseal portions of the bones (sum of Pieces 1, 2, and 3) to those of the epiphyseal portions of the bones (sum of Pieces 4 and 5). Up to thirty-two days after the administration of radio-active phosphorus, this ratio showed a continuous rise. From that time until the last interval (fifty-four days) this ratio either remained unchanged or dropped.

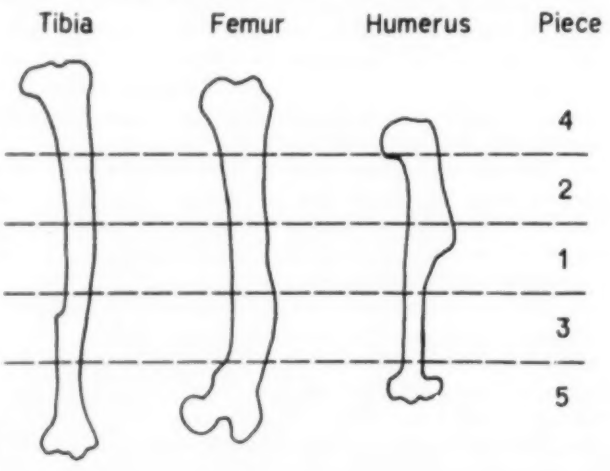

FIG. 1

Each femur, tibia, and humerus was cut into five pieces. The pieces from each bone were numbered as shown in this drawing.

DISCUSSION

The present experiment demonstrates that even fifty-four days after the administration of radio-active phosphorus (P^{32}) to one-week-old rats no equilibrium was reached as regards the distribution of radio-active phosphorus in the skeleton.

The rats used in this experiment were much younger than those used by Neuman and Mulryan. The rats were followed for a considerably longer period of time than those in the experiment of Neuman and Mulryan. It is, therefore, probable that in their experiment, also, no true equilibrium was established.

From Table I it is seen that in the areas of more rapid bone growth the specific activity falls at a more rapid rate than in the areas of slower bone growth. This finding, also, is consistent with the earlier experiment [1] in which radio-active calcium (Ca^{45}) was used.

In Chart I, it is seen that the curve for the diaphyseal to epiphyseal ratio of specific activities crosses the level of unity about five days after the administration of radio-active phosphorus. In the previous experiment [1] in which six-week-old rats were used, the corresponding curve crossed the level of unity twenty to thirty days after the administration of the radio-active isotope. It appears, therefore, that the rate of redistribution of bone salt in the skeleton varies with the age and, hence, with the rate of bone growth of the animals.

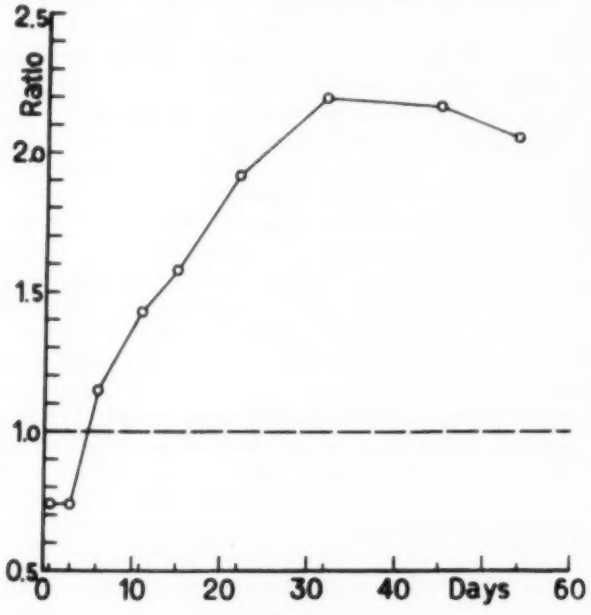

CHART I

Ratio of the specific activity of the diaphyses to that of the epiphyses at varying time intervals after the administration of radio-active phosphorus (P^{32}) to one-week-old rats. Pieces 1, 2, and 3 were from the diaphyses; Pieces 4 and 5 were from the epiphyses.

The redistribution of bone salt in the skeleton may be due to three factors: bone growth, recrystallization, and ionic exchange.

Bone growth means the accretion and the resorption of bone salt due to the remodeling of the entire structure of the bone.

Apart from bone growth, ions are supposedly incorporated in the "interior" of the crystals through dissolution and recrystallization of the crystals.

Ionic exchange means a rapid, reversible process through which ions "on the surface" of the crystals exchange with ions in the surrounding fluid.

Ionic exchange and recrystallization are supposed to favor an equilibration between different skeletal portions and the body fluid. This occurs at a much more rapid rate than that which could be the effect of bone growth.

The present study and a previous study [1] show that the redistribution of administered radio-active phosphorus or radio-active calcium, and, therefore, of bone salt, varies with the skeletal growth of the animal.

Certain authors have been led to assume that other factors than skeletal growth govern this redistribution of bone salt. Thus Singer and his associates [11] seem to believe that exchange processes such as ionic exchange and recrystallization dominate the redistribution of bone salt.

From the work of Neuman and Riley, in 1947, it seems clear, however, that the importance of ionic exchange as a factor in the redistribution of radio-active calcium and radio-active phosphorus rapidly diminishes as time passes after the administration of these isotopes.

Neuman and Mulryan, in 1952, believed that their own data, as well as those of Singer and Armstrong, could be explained as the result of recrystallization. They evidently based this explanation on the assumption that in these two investigations an equilibrium was reached as regards the distribution of isotopes in the skeleton. This assumption does not seem well founded, as has been shown in this study and in a previous study [1].

No other evidence exists concerning the importance of recrystallization for the redistribution of bone salt *in vivo*.

It will be shown that bone growth, on the other hand, can explain what happens during the redistribution of bone salt.

In the present investigation, the ratio of the specific activity of the diaphyses to that of the epiphyses rose to a peak value thirty-two days after the administration of radio-active phosphorus. Thereafter this ratio showed no further increase, and even a slight drop may be found over the longest time interval (fifty-four days).

This variation in the ratio may be expected as the result of bone growth. The radio-active phosphorus initially laid down in the subperiosteal zone during growth in the diaphyses (compare with Leblond, Wilkinson, Bélanger, and Robichon) will ultimately be resorbed. This will happen when the marrow cavity becomes as wide as the external diameter of the bone shaft was at the beginning of the experiment.

When this resorption of highly active bone occurs, the specific activity of the diaphyses will fall at a more rapid rate than that of the epiphyses in which practically all bone of the initial high activity has been resorbed during the remodeling of the bone end.

The ratio of the specific activity of the diaphyses to that of the epiphyses may thus be expected to attain a peak value just before the moment when the initially formed bone of high activity in the diaphyses succumbs to resorption.

As calcium and phosphorus are continuously eliminated from the body, blood activity always falls after administration of the radio-active isotope. The newly formed bone, whether in the shafts or in the ends of the long bones, must have the same activity as blood. Thus bone formed early during an experiment with radio-active calcium or radio-active phosphorus must have a higher specific activity than bone formed in a later period of the same experiment. This difference must be proportional to the decline of the blood activity during the time interval between the formation of the two portions of bone.

It follows that the bone formed after the administration of radio-active phosphorus or radio-active calcium will ultimately have a higher specific activity in those parts of the skeleton in which the time interval between the formation and resorption of the bone is long than in those parts of the skeleton in which this interval is short.

The incisor teeth may serve to illustrate this. It is well known that the tissue of the distal part of an incisor tooth is formed before the tissue of the proximal part.

In an earlier experimental group [1], the author removed the upper incisors of rats at intervals ranging from eighteen hours to sixty-seven days after the administration of radio-active calcium. Each tooth was divided into a proximal half and a distal half by means of a circular blade saw. The specific activities of the different pieces of the teeth were determined.

Chart II shows the variation with time of the ratio of the specific activity of the distal half of the incisor to that of the proximal half of the incisor. It is seen that this ratio rises from a value below unity to a peak value above unity. This peak value was reached about thirty-one days after the administration of radio-active calcium. Sixty-seven days after the administration of radio-active calcium this ratio had dropped slightly, but it was still above unity.

Thus no equilibrium had been reached in spite of the fact that, since the administration of radio-active calcium, the entire tooth had been replaced through protrusive growth and attrition.

The peak of the curve was found to occur at approximately the time when, after the administration of radio-active calcium, the entire distal half of the tooth had been rebuilt. The highly active mineral of the distal tip disappeared through attrition during the later time intervals and, therefore, the curve dropped.

The peak of the curve derived from the diaphyseal to epiphyseal specific-activity ratio in this study (Chart I) was obtained at the time when the tibia had grown to nearly twice its original length. It can be assumed that the diaphyses of the long bones had by that time been entirely rebuilt since the beginning of the experiment. The highly active bone in the diaphyses had disappeared because of resorption; thus the drop in the diaphyseal to epiphyseal ratio of specific activities can be explained.

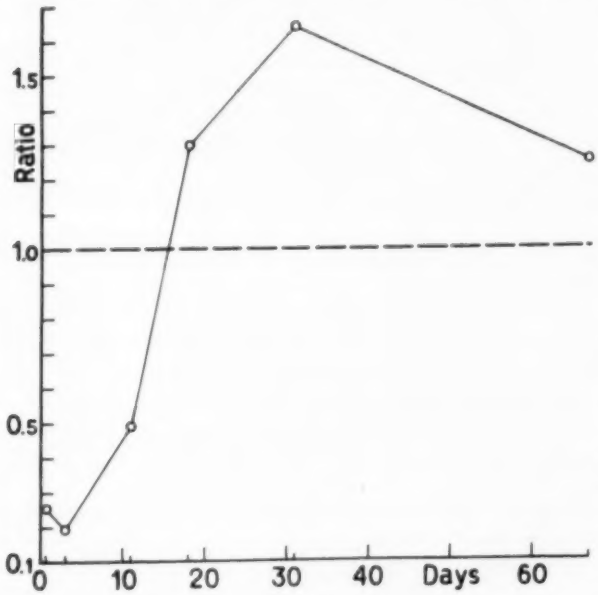

CHART II

Ratio of the specific activity of the distal half of the upper incisor to that of the proximal half at varying time intervals after the administration of radio-active calcium (Ca^{45}) to young rats. This chart was composed from values derived from an earlier experimental group[1].

In a comparison of these events in the incisors and in the long bones, it appears that the activity values in different parts of the skeleton reflect the timetable for the building up and destruction of bone, as well as of dental tissue.

Parts of the skeleton which differ in rate of growth can thus never reach equilibrium with respect to the distribution of radio-active phosphorus or radio-active calcium after administration of these isotopes.

This view is confirmed by the work of Skipper and his associates. From their data it is seen that even 12.7 months after the administration of radio-active sodium bicarbonate ($NaHC^{14}O_3$) to adult growing rats no equilibrium had been established as regards the distribution of radio-active carbon (C^{14}) in the skeleton *.

The conclusions derived from this study and the previous one may be summarized:

* After the present work had been submitted for publication, the author's attention was drawn to two papers from the laboratory of Prof. Lacroix:

Lacroix, Devis, and Schicks[a], in 1952, had found that at seventy-six days after the administration of radio-active phosphorus to adult rabbits, the specific activities of the phosphorus of the epiphyses and diaphyses did not show any tendency to reach uniform values.

Lontie[b], in 1953, had found that the proportional distribution of radio-active calcium in a given bone did not change significantly in a period of about 200 days after the administration of radio-active calcium to adult rabbits. The specific activity encountered in the epiphysis was still above that of the corresponding diaphysis.

[a] LACROIX, P.; DEVIS, R.; and SCHICKS E.: Distribution of Radiophosphorus in the Long Bones of Adult Rabbits. Experientia, **8**: 113, 1952.

[b] LONTIE, P.: Comment se distribue dans la squelette le radiocalcium administré au lapin adulte. Rev. Belge Pathol. et Méd. Expér., **23**: 118-125, 1953.

1. The redistribution of bone salt in different parts of the skeleton varies with the rate of growth of these parts.

2. Compared to skeletal growth, ionic exchange and recrystallization are of minor importance in this redistribution.

3. Parts of the skeleton which differ in rate of growth can thus never reach equilibrium with respect to the distribution of radio-active phosphorus or radio active calcium after administration of these isotopes.

Further work [2, 3, 4] by the author has confirmed the opinions presented in these two papers.

SUMMARY

One-week-old rats were killed at time intervals ranging from eighteen hours to fifty-four days after the administration of radio-active phosphorus. The specific activities of radio-active phosphorus were determined for various parts of the skeleton.

It was found that during these fifty-four days no equilibrium was reached as regards the distribution of radio-active phosphorus in the skeleton. It was further found that the redistribution of radio-active phosphorus in the skeleton varies with skeletal growth.

In the discussion of the importance of these findings, the following conclusions were drawn:

1. The redistribution of bone salt in different parts of the skeleton varies with the rate of growth of these parts.

2. Compared to skeletal growth, ionic exchange and recrystallization are of minor importance in this redistribution.

3. Parts of the skeleton which differ in rate of growth can thus never reach equilibrium with respect to the distribution of radio-active phosphorus or radio-active calcium after administration of these isotopes.

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MONARTICULAR COCCIDIOIDAL ARTHRITIS

Report of a Case with Apparent Cure Following Synovectomy

BY COMMANDER JOHN S. THIEMEYER, JR., *Medical Corps, United States Navy*

Granulomatous inflammation due to *Coccidioides immitis* and involving a solitary joint with apparent cure following synovectomy is not commonly observed. Because of its rarity the condition is reviewed with a case report in order to contrast it with more common types of monarticular effusion.

Exposure to *Coccidioides immitis* has markedly increased during the past decade not only in civilians but in the military, as some military training camps are located in endemic areas. These areas include the San Joaquin Valley of California and parts of Arizona, Utah, West Texas, and New Mexico. Therefore, patients presenting joint effusion should be questioned with reference to their past geographical habitat, regardless of whether they are civilians or members of the armed forces.

Coccidioidomycosis is produced by the diphasic fungus *Coccidioides immitis*. Infection usually occurs by inhalation of the chlamydospores or, rarely, by "inoculation infection". There is no direct man-to-man or animal-to-man infection chain.

The disease produces a primary mild pulmonary involvement often diagnosed as "flu". During the disseminated or secondary phase signs of acute arthritis develop in about a third of the patients; this may appear simultaneously with erythema nodosum. The arthritis usually quickly subsides.

Involvement of joints can occur in the acute benign or in the chronic granulomatous phase of infection. It is the latter which is sinister and may be the forerunner of disseminated disease which will lead to death. Survival is the rule for the acute phase, but the mortality is high in the granulomatous phase.

Miller and Birsner reported on seventeen patients with bone involvement of whom nine had lung involvement demonstrable at the same time and eight did not. In this group the serological tests were 100 per cent. positive, but skin tests were not always so. A negative coccidioidin skin test may therefore be of no value. Complete proof of coccidioidomycosis, it is generally believed, can be had only by demonstration of the fungus, either microscopically in tissue or by combined culture and animal inoculation.

Numerous cases of granulomatous involvement of bone are reported, but only a few cases of solitary joint involvement without involvement elsewhere appear in the literature.

The joints are usually swollen and red at first and later are fluctuant. Nodular lesions may develop in the skin overlying the joints and these may ulcerate and discharge pus containing *Coccidioides immitis*. McMaster and Gilfillan expressed the opinion that joints may be primarily affected by direct involvement of the synovial membrane, or infection may extend to joints from adjacent foci of coccidioidal osteomyelitis. Of twenty-four cases reported by them in which involvement of bones and joints was noted, primary localization in synovial membrane was present in four—in the ankle in one, in the hip in one, and in the knee joint in two.

Carter mentioned one case of involvement of the knee with swelling only and with apparent cure by synovectomy. Smith reported that excision, arthrodesis, or amputation had occasionally cured single lesions and McMaster and Gilfillan advocated arthrodesis or amputation as the treatment of choice in joint involvement. Treatment of single-joint involvement by synovectomy is suggested by the following case report.

The patient, a United States Army Major, thirty-five years old, was admitted to the United States Naval Hospital, St. Albans, Long Island, New York, on July 12, 1950, with the diagnosis of internal derangement of the right knee. The historical facts pertinent to his illness were as follows:

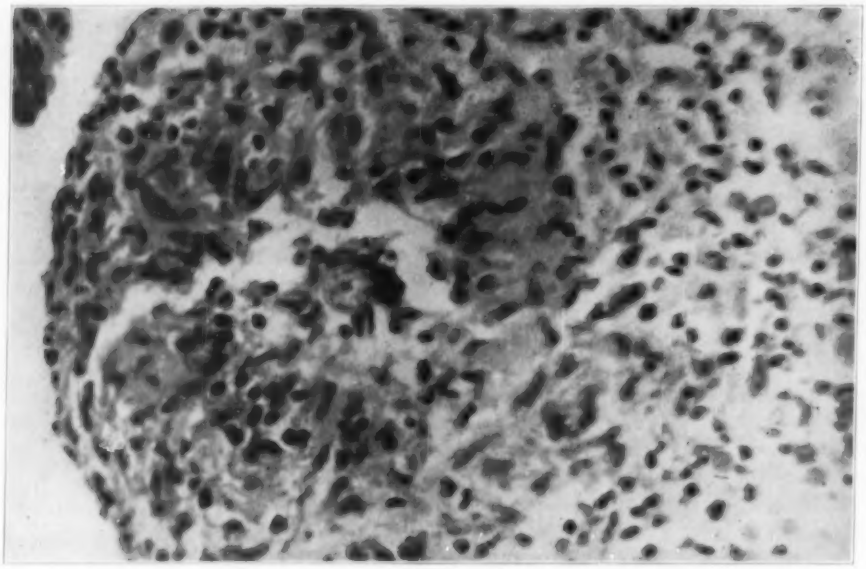

FIG. 1

Photomicrograph (approximately × 300) of synovial lesion, showing granuloma and spherule with refractile wall and endospores.

During April, May, June, and July of 1943, he was in desert training at Hyder, Arizona. (It is now known that there was a significant incidence of infection with *Coccidioides immitis* among the troops who were trained there.) The patient did not remember having had any severe infections of the respiratory tract other than the usual "colds" during that period. In September 1943, during night training at Fort Benning, Georgia, he ran against a low wire fence, striking his right knee, and was thrown to the ground. He did not sustain an open abrasion, but his knee became swollen and he limped. After four or five days, the swelling subsided and he had no further trouble with the knee until 1945 when, during combat operations in the Philippines and at Okinawa, he began to have occasional episodes of painless swelling of the right knee joint. The swelling each time subsided after a few days. Thereafter, swelling occurred intermittently on the average of once a month.

Beginning about September 1947, the episodes became more frequent and gradually increased in duration and severity until by the middle of the following year the swelling had become permanent. In addition, during 1947 and 1948, the swelling had begun to limit flexion of the extremity and pain had appeared. An elastic bandage support was then used about the knee and the leg began to show oedema.

Because of the pressure of his duties as an instructor at the Aberdeen Proving Gounds, the patient did not seek medical advice.

During the winter of 1949–1950 increased swelling of the knee began to interfere with both flexion and extension to such a degree that he limped and pain developed deep under the right patella after he had been standing for several hours. In June 1950, he finally turned in on the sick list and was transferred to the St. Albans Naval Hospital.

On admission, the significant physical findings were confined to the region of the right knee joint and the leg. There was moderate pitting oedema about the right ankle and proximal end of the tibia. There was swelling about the right knee, the circumference of which was one inch greater than that of the left. The knee joint contained fluid. Flexion was decreased by 15 degrees. There was no redness or tenderness. Roentgenograms of the right knee and of other bones and joints revealed no abnormalities. Examination of fluid aspirated from the joint showed it to be within normal limits. Blood count, sedimentation rate, blood Kahn test, urinalysis, stool examinations, and determinations of blood glucose, electrolytes, and proteins were within normal limits or not diagnostic. Roentgenograms of the chest, however, disclosed a small area of fibrous scarring at the level of the first rib in the left apex.

On July 26, 1950, a total synovectomy of the right knee joint was performed. A considerable amount of viscid, straw-colored fluid was evacuated from the joint space. The synovial membrane showed generalized thickening; it was dark red in color, granular, and speckled in places with small white bodies. After operation, the wound drained serous fluid through a small sinus for sixteen days and then closed and has remained closed to the present. The patient had a moderate fever for five weeks after operation. He was placed on

FIG. 2-A

FIG. 2-B

Anteroposterior and lateral roentgenograms of the right knee, made in September 1952, two years after synovectomy. There was no evidence of significant bone or joint changes.

crystalline penicillin, 100,000 units every four hours, for the first week after operation and was then given 300,000 units of procaine penicillin twice daily for one week.

The pathologists demonstrated that the excised synovial membrane showed infection with *Coccidioides immitis* (Fig. 1). Several consultant pathologists who examined the microscopic sections concurred in the diagnosis. The organism had also been cultured from the sinus.

After the patient's fever had subsided, he was permitted to get about on crutches for several months and was then allowed limited ambulation and weight-bearing on the knee joint but still with some aid of crutches. He became fatigued easily and his knee tended to swell after slight activity. Motion of the joint was limited to 135 degrees of flexion, a loss of approximately 100 degrees of the normal range. The joint also remained indurated and swollen and measured 2.5 centimeters greater in circumference than the left. There was atrophy of the right thigh muscles, which measured 3.75 centimeters less in circumference than those of the left thigh, and there was moderate but persistent oedema of the right leg.

Roentgenograms made on February 7, 1951, showed no further changes in the lungs, but disclosed generalized demineralization of the bones about the right knee joint and cystic changes in the distal end of the femur. The abnormal roentgenographic findings were considered to be due either to disuse atrophy of bone or possibly to involvement of the bone by coccidioidomycosis. The complement-fixation tests for coccidioidomycosis, which were performed by Dr. Charles E. Smith in September and December 1950 and February 1951, showed originally a maximal titer of 1:16, then 1:32, and again 1:32. The results were interpreted by him as evidence of continuing infection, and he gave a guarded prognosis.

It appears then that this patient had acquired an asymptomatic pulmonary infection by *Coccidioides immitis* when he was in training in an endemic area in the summer of 1943. The secondary granulomatous phase of the condition became apparent in the right knee in September 1943. During the next several years the disease in the joint pursued an indolent but progressive course, until it finally became disabling; it was then diagnosed and treated.

The patient has been followed at regular intervals. When he was examined on December 18, 1951, he was asymptomatic, had lost no weight, and had no pain or swelling of any of the joints. Examination of the right knee revealed the wound from the arthrotomy to be well healed and non-tender. There was no swelling, redness, brawniness, or thickening about the joint and no effusion. He could actively extend the knee to 180 degrees and flex to 100 degrees, a total of 80 degrees. Roentgenographic findings at that time were as follows:

"X-ray examination of the right knee shows a slight narrowing of the joint interspace, but no other significant abnormality is visualized. In review of the old films the previously described osteoporosis in the distal end of the femur has completely disappeared. The bones now have a normal mineralization and trabecular pattern. The narrowing of the joint interspace is probably the result of the previous surgery."

Serological tests for coccidioidal infection reported by the University of California School of Public Health were as follows:

"Blood specimen received 27 December 1951

Complement fixation tests: Serial dilutions of serum (0.25 cubic centimeter):

1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256
+++	+++	+++	0	0			

Precipitin Tests: Serial dilutions of antigen:

Undiluted	1:10	1:40	1:100
0	0	0	

"The findings are essentially as they were in February. . . . The continued low-titered serology would be what we would have anticipated and is in line with favorable clinical status."

The patient was again examined on September 11, 1952. He was feeling well and appeared well nourished, alert, and active. He stated that he had no complaints except for some transient swelling of the right leg after long standing, but no knee pain, redness, brawniness, or swelling.

The range of motion of the knee was the same as before and the circumference as compared with the normal side was as follows:

	Left (*Centimeters*)	Right (*Centimeters*)
Fifteen centimeters above mid-line of patella	44.7	42.2
Mid-line of patella	37.3	37.5
Fifteen centimeters below mid-line of patella	34.1	32.5

Roentgenograms made at this time revealed no significant bone or joint changes (Figs. 2-A and 2-B)

Blood studies were as follows:

Red blood cells		4,920,000 per cubic millimeter
Hemoglobin		14.5 grams per 100 cubic centimeters
White blood cells		6,800 per cubic millimeter
Neutrophils	66 per cent.	
Eosinophils	2 per cent.	
Lymphocytes	30 per cent.	
Basophils	2 per cent.	

The blood morphology was normal.

The most recent serological tests reported on January 5, 1953, from the University of California School of Public Health were as follows:

"Complement fixation tests: Serial dilutions of serum (0.25 cubic centimeter):

1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256
++++	++++	+++	0	0			

Precipitin Tests: Serial dilutions of antigen:

Undiluted	1:10	1:40	1:100
0	0	0	

"Findings same as a year ago. Evidently the infection has stabilized, in line with favorable clinical picture."

In summary, while synovectomy is a departure from the usual treatment of arthrodesis or amputation, it may be considered in selected future cases of monarticular coccidioidomycosis as an effective and non-deforming procedure.

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COCCIDIOIDAL TENOSYNOVITIS

Report of a Case

BY O. R. WALKER, M.D., AND R. H. HALL, M.D., LONG BEACH, CALIFORNIA

From the Orthopaedic Surgical Section, Veterans Administration Hospital, Long Beach

Clinical, gross, and micropathological similarities between tuberculous and coccidioidal infections are well recognized. Frequent reports of tuberculous granulomatous synovitis and tenosynovitis alone without involvement of adjacent bone suggest the presence of a coccidioidal counterpart not recognized or not reported. The following case is presented as representative of this condition, since synovial structures alone were involved in a granulomatous process of coccidioidal etiology without apparent involvement of adjacent bone structure.

CASE REPORT

History: The patient was a mechanic, twenty-six years old, who had noted the onset of swelling over the ulnar surface of the right wrist in 1948. One year later he was aware that there was also a swelling and a moderate amount of pain along the hypothenar eminence and the fifth finger of the right hand. Since the degree of swelling had varied somewhat with activity, the patient did not seek medical attention until two years after the onset of the swelling on the wrist. At this time a surgical exploration of the swelling of the right hand was performed and, on the basis of gross and microscopic studies, a diagnosis of chronic tuberculous tenosynovitis was made, although no acid-fast organisms were identified, either by stained slides or by culture. Postoperatively intensive treatment with aureomycin, streptomycin, and penicillin was administered, as well as roentgen therapy to the right hand and forearm.

The patient remained asymptomatic for approximately ten months, at which time he again noted a feeling of tightness and swelling of the right palm. Swelling of the right thumb and thenar eminence and of the flexor tendons of the middle and fifth fingers had been progressive and on admission to the Long Beach Veterans Administration Hospital, on August 13, 1952, there was marked limitation of motion of the right wrist and of the affected fingers.

Examination on admission: Several areas of soft fluctuance with crepitation along the palmar aspect of the flexor tendons of the right middle and fifth fingers and over the hypothenar eminence were noted. There was also a large area of fluctuation with crepitation of the left ulnar bursa. All of these areas were non-tender and there was no evidence of inflammation.

Laboratory examination: Upon admission, blood count and urinalysis gave findings within normal limits. The first-strength purified protein derivative test was + in forty-eight hours. The coccidioidin skin test, made in October 1952, was negative at a dilution of 1:1000, but slightly positive at a dilution of 1:100.

Roentgenograms of the forearm, wrist, and hand revealed no abnormalities in bone, although the soft-tissue swellings were readily visualized. A chest roentgenogram was reported as showing one area of increased linear density suggesting fibrosis and consistent with a residuum of an old infection with acid-fast organisms.

Hospital course: On the day after admission the right ulnar and radial bursae and the flexor tendon sheaths of the fifth, middle, and index fingers were all excised. They were found to be distended with a thin, yellowish fluid, and many rice bodies were distributed throughout the sheath. Approximately three weeks later the patient complained of a feeling of fullness and crepitation over the left hip. Examination revealed the crepitation to be in the area immediately distal to the left greater trochanter, where there was a slight amount of swelling but no tenderness. This area was explored surgically on September 30, 1952, and a large bursa approximately ten centimeters in length, lying between the fascia lata and the vastus lateralis, was identified; it was found to be distended with serous fluid and many "melon-seed" bodies, larger in size and flatter than rice bodies. It was not possible to identify any continuity with the shaft or the trochanter of the left femur, and the entire bursa was excised intact much in the manner of a hernial sac.

Microscopic examination of the bursa thus obtained revealed many doubly refractile spherules with endospores, and a diagnosis of coccidioidomycosis was made. As a consequence, slides from tissue obtained from the right hand were re-examined and in these also spherules with endospores were identified. A serum was obtained for coccidioidal complement-fixation tests and on November 2, 1952, this was reported as being positive at a dilution of 1:128.

The postoperative course was brief and uneventful and the patient was discharged ambulatory and asymptomatic one month after the second operation. He had received no specific medication other than a brief course of para-aminosalicylic acid and streptomycin in the interval between surgery upon the right

hand and the establishment of a definite diagnosis of coccidioidomycosis of both the hand and the area in the left hip. At the time of discharge the patient was apparently in good general health and the only residual disability was a flexion contracture of the right middle finger.

Follow-up studies: Some recurrent synovial involvement proximal to the wrist joint was noted when the patient was seen again. Coccidioidin skin tests were as follows:

February 13, 1953: positive at 1:100;
May 14, 1953: weakly positive at 1:100;
August 19, 1953: negative at 1:100;
October 22, 1953: slightly positive at 1:100;
November 12, 1953: negative at 1:100.

The serum complement-fixation tests were as follows:

February 12, 1953: positive at 1:128;
May 13, 1953: positive at 1:64;
August 18, 1953: positive at 1:64;
October 21, 1953: positive at 1:64.

On November 25, 1953, the purified protein derivative test, first strength, was negative, and on November 27, 1953, the purified protein derivative test, second strength, was negative.

Clinically, when the patient was last seen, he still had a severe flexion contracture of the middle finger, moderate contracture of the fifth and mild contracture of the ring fingers, all of the right hand. A fluctuant soft-tissue synovial mass was palpable above the carpal ligaments. There was also synovial thickening and increased fluid within the elbow joint on the right side. The left trochanteric bursal area was asymptomatic subjectively and objectively. Roentgenograms of the chest, made repeatedly, showed no changes. Roentgenograms of the spine, pelvis, right elbow, and right wrist, made on November 23, 1953, showed no involvement of bone.

DISCUSSION

A survey of the literature has failed to reveal any previously recorded strictly synovial manifestation of coccidioidal infection. In those cases in which synovial structures were involved, the infection took place on a contiguity basis from an adjacent focus of infection within a bone or joint [3, 4]. The presence of rice bodies and the gross appearance of chronic tuberculous tenosynovitis of the hand are said to be nearly diagnostic [1, 2]. In this case, the clinical, preoperative, and operative findings were seemingly those typical of tuberculous tenosynovitis. However, in view of the established coccidioidal etiology, the authors would like to emphasize the importance of accurate cultural and microscopic studies and suggest caution in the treatment of the chronic tenosynovitides on the basis of clinical findings alone.

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ARACHNOIDITIS FOLLOWING THE USE OF IODIZED OIL *

BY EVERETT F. HURTEAU, M.D., WILLIAM C. BAIRD, M.D., AND
ERNEST SINCLAIR, M.D., AKRON, OHIO

It is the purpose of this paper to present clinical and experimental data which suggested to us that pantopaque [ethyl—10—(P-iodophenyl) undecylate] and other iodized oils may contribute to severe and disabling arachnoiditis. Peacher and Robertson, in their excellent report of 300 cases, concluded that "No gross pathological changes were evident in cases where the subarachnoid space has been exposed at varying periods following [pantopaque] spinogram". Encystment and nerve-root irritation were not observed by them and meningeal response was "minimal and transient". In one of our cases, encystment of pantopaque did occur, and the localized nature of the reaction about the drug indicated that the pantopaque was the cause of this reaction.

EXPERIMENTAL DATA

Twelve dogs were used for these experiments. Three cubic centimeters of pantopaque was injected into the cisterna cerebellomedullaris of one group of these animals. The head was held in a dependent position immediately after injection. The dogs were sacrificed from six days to eight weeks after insertion of pantopaque, and roentgenograms of the head were made just before each animal was sacrificed. These x-rays showed pantopaque scattered about the cisternae basales (Fig. 1). Gross and microscopic studies were made of the brains, and attention was focused especially upon the meninges about the cisternae basales.

There was a meningeal reaction in all the dogs in this group which varied in intensity

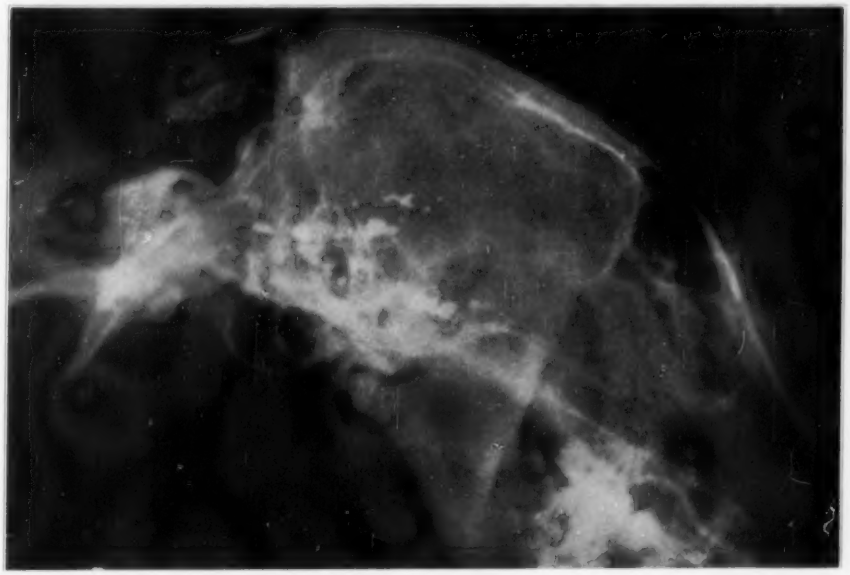

FIG. 1

Roentgenogram of head of dog showing pantopaque in cisternae basales.

* Read at the Annual Meeting of The Neurosurgical Society of America, Sea Island, Georgia, September 20, 1952.

FIG. 2

Brains of dogs showing difference in degree of reaction in different animals. Pantopaque had been inserted into the cisternae basales of both of these animals nineteen days previously; antemortem x-rays showed that it was still present. Note the globules of oil over the base (*O*).

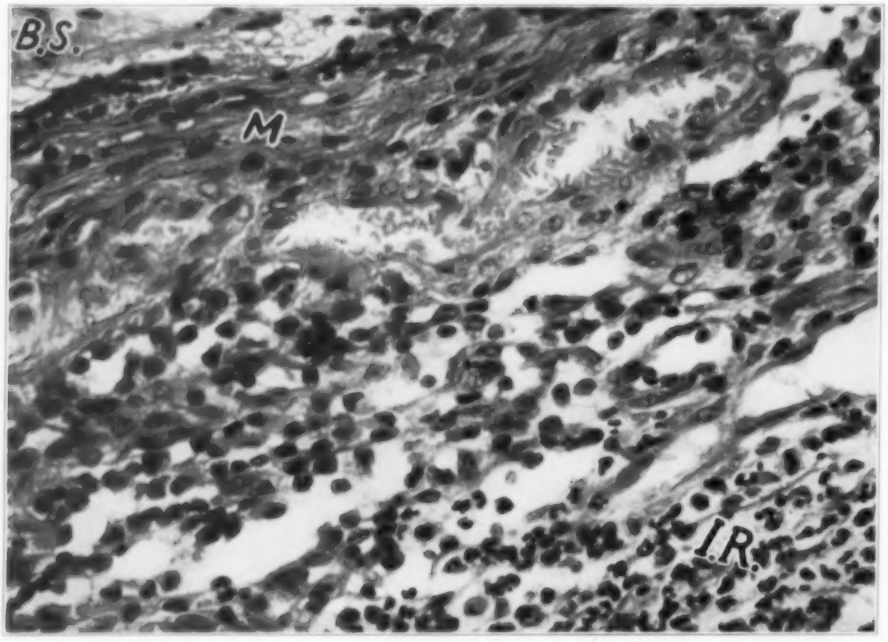

FIG. 3

Photomicrograph (× 175) showing chemical meningitis. This dog had been sacrificed nineteen days after insertion of pantopaque into the subarachnoid space. Brain stem, *B. S.*; meninges, *M.*; inflammatory reaction, *I. R.*

(Fig. 2), but tended to become more pronounced as time passed. Thus the degree of reaction on microscopic examination was much less in animals sacrificed six days after insertion of the material than in those sacrificed several weeks later. After two weeks in some there was a severe cellular reaction in the meninges about the base of the brain similar to that seen in bacterial meningitis (Fig. 3). This included the presence of round cells, polymorphonuclear cells, macrophage infiltration, and deposition of fibrin. No ventriculitis was evident. Several of these animals which had been docile before insertion became irritable thereafter and remained irritable.

There was little or no reaction to pantopaque inserted into the peritoneal cavity, pleural cavity, or on the conjunctiva. This may be due in part to the fact that the pleural and peritoneal cavities of dogs are relatively resistant. Pantopaque was probably eliminated from the conjunctiva immediately by tearing.

CLINICAL DATA

Case 1. N. K., a male, thirty-seven years old, began to experience pain in the low back and in the right lower extremity while he was lifting a heavy object in October 1947. Pain had been aggravated by stooping, bending, and lifting, and there had been some radiation to the right thigh. He had been hospitalized in several institutions for this complaint. On March 18 and 20, 1948, myelograms had been made for which pantopaque was used. These were regarded as normal (Figs. 4-A and 4-B). At that time his temperature and pulse had been normal. Records were scanty, but there was no indication that an attempt had been made to remove the pantopaque from the subarachnoid space. No cerebrospinal-fluid studies made before insertion of pantopaque were available. Nine days after myelography the patient had been rehospitalized, complaining of severe pain in the low back and in both lower extremities. On this re-admission his temperature was 101.5, pulse 90. Again no attempt was made to remove the pantopaque and a diagnosis of psychoneurosis was made. In July 1949, he had been studied in the orthopaedic department of another institution; the report stated that "x-rays of the lumbosacral region showed evidence of pantopaque oil in the spinal canal". Neurological findings were reportedly within normal limits. He was seen again at the same institution in July 1950, complaining of pain in the chest, low back, and right lower extremity. Roentgenograms of the lumbosacral spine again showed pantopaque within the spinal canal.

On August 19, 1950, one of the authors was asked to see this patient. He complained of low-back and bilateral sciatic pain. There had been recent weakness of the lower extremities, loss of libido, and incontinence of bowel and bladder. Examination at this time revealed hypo-algesia which included all lumbar and sacral segments. The ankle jerks and knee jerks were absent. There was some limitation of back motion. Straight-leg raising was limited bilaterally. A pantopaque myelogram had been made the preceding day (Figs. 4-C and 4-D), which showed a complete obstruction to the flow of pantopaque below the fourth lumbar level and revealed the presence of two immovable collections of pantopaque at the lumbosacral level. Above this level the contrast medium flowed freely without abnormality. Following this procedure the newly injected oil was removed. The two immovable collections remained fixed (Fig. 4-E).

On August 23, 1950, a laminectomy was done. There was no spinal fluid below the fourth lumbar level. The cauda equina appeared as a ropelike mass of nerve roots and connective tissue without any cleavage lines. In the center of this adhesive mass was found a cyst, measuring approximately one-half inch in diameter, which contained an oily material resembling pantopaque. It corresponded in size and position to the immovable collection of pantopaque noted on the roentgenograms. Futile attempts at lysis of adhesions were abandoned. No herniation of the intervertebral disc at the fourth or fifth interspace was noted.

The patient's postoperative course was uneventful. He received a course of deep roentgen therapy (1,000 r) to the cauda equina, and seemed to gain some benefit therefrom.

Case 2. M. H., a female, twenty-nine years old, had first noted pain in the low back and right lower extremity in 1940. In 1949 she had been operated upon for a herniated disc; six months later a fusion had been done by the same surgeon. She had experienced bilateral lower-extremity pain since lipiodol myelography preceding her first operation. These myelograms reportedly showed no abnormalities. She also had experienced some neck and shoulder pain which dated from the time of her myelograms.

On July 14, 1951, this patient was first seen by one of the authors. The pain in the low back and lower extremities had progressed. On examination she showed limitation of anterior bending. There was well defined hypo-algesia over the distribution of the first sacral segments bilaterally, more marked on the left than on the right. There was less marked hypo-algesia of all sacral and lower lumbar segments, with a vague sensory level at the second lumbar segment. Weakness of dorsiflexion of the left foot was evident. Knee jerks and ankle jerks were within physiological limits. A roentgenogram (Fig. 5-A) of the lumbosacral spine revealed disseminated globules of radiopaque material scattered about the subarachnoid space throughout the lumbar and sacral levels. Graft fragments were also present. The patient was discharged, but was re-

hospitalized nine months later. Myelograms made at that time revealed a complete obstruction at the lower margin of the fifth lumbar vertebra (Figs. 5-B and 5-C). There was no abnormality of the flow of the oil above this level.

On February 29, 1952, a laminectomy was done. This revealed a severe adhesive arachnoiditis throughout the lumbar region. From the lower margin of the fifth lumbar vertebra caudally the entire dural sac was filled with a mass of connective tissue in which the cauda equina was firmly incorporated. Within this mass many small cysts were found which measured up to three millimeters in diameter. These contained an oily substance and presumably represented encysted lipiodol. Following laminectomy, the patient received deep roentgen therapy (1,200 r) to the cauda equina. Her pain continued to be intractable, especially in her left lower extremity. On May 19, 1952, a right dorsal cordotomy was done. This relieved the pain in the left lower limb, and it is anticipated that a left cordotomy will be necessary.

Case 3. D. L., a white male, forty-nine years old, had onset of low-back pain while he was lifting on February 21, 1950. There were recurrences of low-back pain with some radiation to the left lower extremity, precipitated by lifting or sneezing. On March 23, 1950, cerebrospinal fluid was removed and pantopaque was inserted. This cerebrospinal fluid showed protein of 58 milligrams per 100 cubic centimeters, one cell, and negative globulin. The pantopaque was removed, except for what was reported to be a small residuum. Subsequently x-rays showed a relatively large amount of pantopaque which had not been removed. Roentgenograms made nine months later showed that most of the radiopaque portion of this residuum had disappeared.

On December 19, 1951, the patient was first seen by one of the authors. At this time there was bilateral limitation of straight-leg raising and saddle hypo-algesia, together with hypo-algesia over both dermatomes of the first sacral segment. Cerebrospinal fluid removed at that time showed the total protein to be 182 milligrams per 100 cubic centimeters, and a test for the presence of globulin was positive. A myelogram was made, but no significant abnormality was found. All but two cubic centimeters of the pantopaque was removed. Because of persistence of pain and saddle hypo-algesia, a third myelogram was made on May 1, 1952, again without significant positive findings. Cerebrospinal fluid removed contained seventy-five milligrams of protein per 100 cubic centimeters and no cells.

Fig. 4-A

Fig. 4-B

Case 1. First (normal) lumbar myelograms.

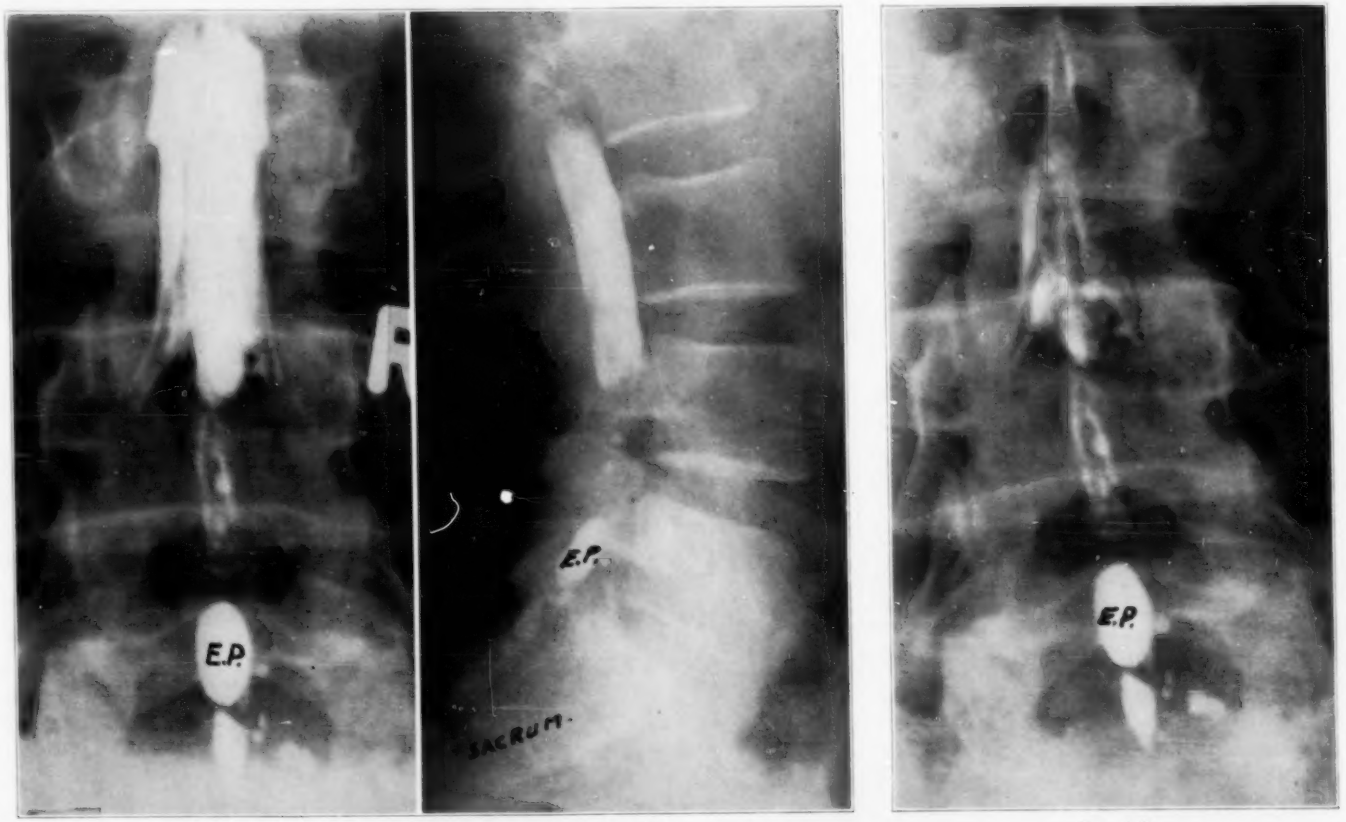

FIG. 4-C

FIG. 4-D

FIG. 4-E

Figs. 4-C and 4-D: The second lumbar myelograms showed complete obstruction at the fourth lumbar level, as well as a globule of encysted pantopaque (*E. P.*) which remained from the first myelography.

Fig. 4-E: The pantopaque used in the second myelograms was removed, but the residual encysted pantopaque (*E. P.*) remained from the first myelograms.

On May 9, 1952, a laminectomy was done. The fifth interspace was found to be almost completely devoid of disc material, but no protrusion of disc material was found. Upon opening of the dura, a mass of dense adhesions was found which extended from the tip of the dural sac about one and one-half inches rostrally. The cauda equina was incorporated in these adhesions. There was no evidence of encysted pantopaque. Following operation the patient received deep x-ray treatment (1,000 r) to the cauda equina with some apparent improvement.

COMMENT

Various observers [4, 6] have felt that the rate of absorption of pantopaque from the subarachnoid space was variable, but that it proceeded in a regular manner. These conclusions were usually based on follow-up roentgenograms. We have not been convinced that all of the substance is ever absorbed, but we have felt that perhaps only the radiopaque portion disappears, whereas the vehicle remains behind indefinitely. It is imperative to completely remove the pantopaque from the subarachnoid space immediately after myelography. The procedure of choice is to leave the needle through which the material was inserted in place during fluoroscopy and roentgen examination and then to aspirate the oil through the same needle immediately.

Variability of reaction to pantopaque in different patients has been attributed to differences in tolerance to iodine and to the "chemical condition of the material" [4]. Luce and his associates felt that severe reactions, seen nine days after myelography in one case and thirty days after myelography in another, were due to sensitivity of patients to the contrast medium. In their cases, delayed meningeal reaction was accompanied by exacerbations of reactions at the skin-test site. We have felt on several occasions that a series of immediate meningeal reactions more severe than usual seemed to be correlated with a new lot of pantopaque. This suggested to us that there might be some variation in the irritation produced by different samples of the opaque substance. Investigation of these offending lots by the manufacturer, however, did not disclose anything unusual. Variations in the degree of aseptic meningitis in the animals studied would correspond to the variations in clinical manifestation of meningeal irritation in patients and would seem to indicate variation in sensitivity in human subjects. This could be a variation in iodine sensitivity.

The immediate reaction to pantopaque which manifests itself clinically by signs of radiculitis and fever, is usually a transient one. It is often of sufficient magnitude, however, to obscure findings which had been present before myelography. It has led us to encourage consultation prior to myelography, rather than to condone myelography as a "screening" procedure. This immediate reaction is well illustrated in the case reported by Tarlov. Operation sixty hours after insertion of pantopaque in his case revealed an exudate simulating purulent material which was already adherent to the roots of the cauda equina. We have occasionally noted pantopaque, which is freely movable on the day of insertion, to become fixed and immovable twenty-four hours after insertion. We have been at a loss to explain this, but it would seem to correspond to Tarlov's exudate and probably represents solidification of the contrast medium.

Others [2, 5] who have observed adhesive arachnoiditis have attributed it to disc surgery or disc disease. The common denominator in these reports, however, seems to be pantopaque or some other iodized oil. Several of the myelograms in Smolik and Nash's paper are quite similar to those of Case 1 reported by the author. The operative findings in this case and in Case 2 are similar to the arachnoid cysts which Bucy and Speigel attributed to iodized oil.

In all three cases herein presented, severe arachnoiditis was proved by exploratory laminectomy. In one case (Case 3) most of the iodized oil had been removed. In the other two no attempt at removal had been made. In only one case (Case 2) could previous operation possibly have been a contributing factor. The localized nature of this arachnoiditis and the presence of fixed and completely encysted iodized oil deep within the con-

FIG. 5-A

FIG. 5-B

FIG. 5-C

Fig. 5-A: Case 2. Lumbosacral roentgenograms showed residual lipiodol which had remained from the first myelography.
Figs. 5-B and 5-C: Later lumbar myelograms showed complete obstruction at the fifth lumbar level.

nective-tissue mass indicated that the adhesive process was, at least in part, a walling-off, foreign-body type of reaction to the iodized oil. The absence of any myelographic abnormality when the oil was first inserted and the development of complete obstruction to the flow of subsequently injected oil at a level above the older walled-off oil substantiated this conclusion. Pre-existing mild arachnoiditis could not be ruled out with certainty, however.

SUMMARY

1. Clinical and laboratory data presented suggest that pantopaque and other iodized oils may contribute to, or possibly cause, severe reaction within the subarachnoid space.

2. Verbal communication indicating similar experience among orthopaedists and neurosurgeons has suggested to us that there is need for a more critical evaluation of the properties of pantopaque and other iodized oils and a more conservative approach to their use than is often practised. The importance of complete removal of the substance is evident.

NOTE: The authors wish to acknowledge with gratitude the assistance given by the Pathology Laboratory, X-Ray Department, and Animal Laboratory of The City Hospital of Akron. Pantopaque was supplied by the Picker X-Ray Corporation.

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A SIMPLE EFFICIENT EXTRACTOR FOR REMOVING CLOVER-LEAF INTRAMEDULLARY RODS

BY HOWARD L. CHERRY, M.D., PORTLAND, OREGON

When the usual instruments are employed to remove a clover-leaf intramedullary rod, there is often considerable difficulty in getting exposure through which the rod can be grasped. With the simple instrument illustrated, this difficulty is eliminated.

The instrument is made by welding a screw extractor to an appropriate handle. The extractor is a small, bitlike device, with left-handed threads, designed to screw out broken-

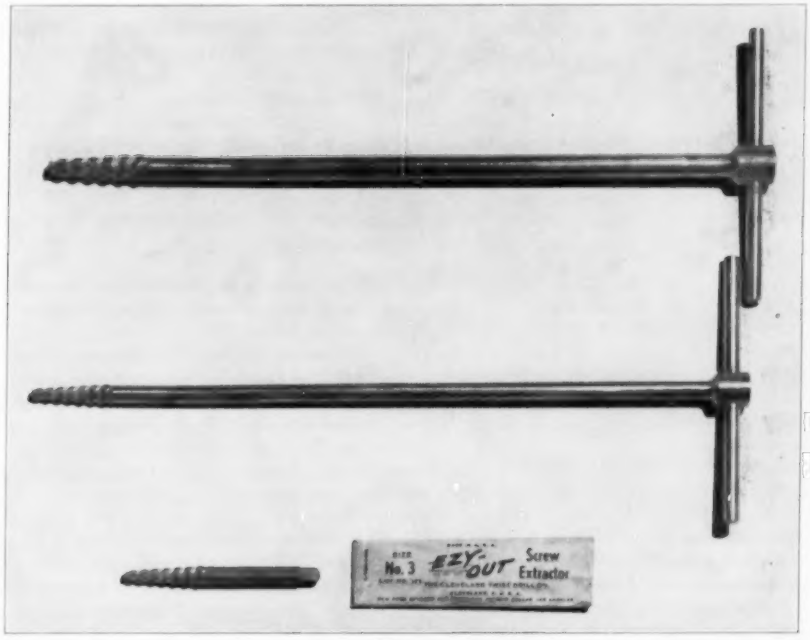

FIG. 1

Reading from top to bottom: No. 4 and No. 3 "Ezy-Out" screw extractors which have been welded to handles, and a screw extractor before it has been welded.

off bolts in blocks. It may be procured from any machinists' supply house. There are several types on the market.* Some do not grip the intramedullary rod firmly.

To use the extractor, a small incision is made over the tip of the intramedullary rod. The tip of the rod is then located with the finger, and the rod is jarred with an inserter. The jarring serves to free the rod if it is "frozen". Then the extractor is inserted into the rod and is given a counter-clockwise twist so that it will bite into the walls of the rod. The stainless steel of the rod is soft enough to permit the extractor to exert a strong hold with only hand pressure. When the extractor is firmly in place, the rod can be pulled out. In all instances in which the extractor has been used, the rod has come out easily, without having to be hammered.

Because the extractor goes inside the clover-leaf intramedullary rod, not on the outside or through the slot, it is possible to insert the rod flush with the bony cortex so that it does not project far enough to cause irritation in muscle or joint structures. Through a small incision, with minimal dissection, the rod can be removed easily.

In the past year we have used this device in fifteen cases. In most of these an intramedullary nail was removed from the femur without difficulty; in two the device was used for the humerus. In one case we did not find it adequate to extract an extremely tight six-millimeter nail from an ulna; the bone had to be chipped away and a chisel was used to extract the nail.

* The "Ezy-Out" screw extractor, manufactured by the Cleveland Twist Drill Company, is recommended. A No. 3 "Ezy-Out" extractor fits all clover-leaf rods except the thin-walled rods with diameters of 11 and 12 millimeters, for which a No. 4 "Ezy-Out" extractor may be used.

AN UNUSUAL OSTEOCHONDRAL TUMOR

BY H. ROSS HUME, JR., M.D., ANN ARBOR, MICHIGAN

From the Department of Orthopaedics, University of Michigan, Ann Arbor, Michigan and the Department of Surgery, Wayne County General Hospital, Eloise, Michigan

Although osteochondromata are not uncommon, the following case is presented because it represents an osteochondral tumor with several unusual features.

A woman, thirty-six years old, a hospital attendant, was first seen on June 1, 1941, after being kicked in the right ankle. Physical examination at this time revealed no significant abnormalities. No deformity was demonstrated by roentgenographic examination of her ankle.

She was seen six years later, on April 8, 1947, six days after having sprained the right ankle. There was a pronounced swelling inferior to the lateral malleolus. Although this was cystic to palpation, nothing could be aspirated. Roentgenograms at that time showed two calcified masses anterior to the lateral malleolus. There was no evidence of fracture of the tibia or fibula. After a period of support with adhesive strapping, her ankle was asymptomatic.

On December 17, 1951 (four years and eight months later), the patient, now forty-nine years of age, fell from a ladder and bruised her right ankle, knee, and hip. There was a palpable swelling over the anterior and lateral aspects of the right ankle. Motions of this joint were painful, and the swelling was tender to pressure. Roentgenograms of the ankle were now interpreted as showing an ossifying hematoma. The leg was placed in a short walking cast for one month. When it was removed, the ankle was again asymptomatic. However, one month later she returned because of increased swelling; when next seen, one month after this visit, she complained of tingling on the dorsal aspect of the fourth and fifth toes. No sensory defect was demonstrated, but there was weakness of plantar flexion of the foot. At this time roentgenograms made with the extremity held in external rotation demonstrated an osseous mass arising from the anterolateral aspect of the tibia and extending laterally in front of the fibula (Figs. 1-A and 1-B). The central portion of this bony mass had the appearance of a free ossicle, approximately one centimeter in diameter, which articulated on one side with the portion of the bony mass projecting from the tibia on the other side; a similar mass apparently arose from the fibula.

FIG. 1-A FIG. 1-B

Roentgenograms of the right ankle made in March 1952.

When exposed at operation on April 1, 1952, there was a firm mass, two centimeters in length and one centimeter in diameter, which arose from the anterolateral aspect of the right tibia just above the ankle joint and projected distally in hooklike fashion. It was covered with a fibrous capsule (Fig. 2). There was a definite pseudarthrosis with capsule and soft, glistening, cartilaginous joint surfaces between the central ossicle and tibial portion of the mass. The lesion, when viewed microscopically, appeared to consist of mature bone, cartilage, and an enveloping fibrous capsule (Fig. 3). The bony and cartilaginous architecture was irregular and did not present the characteristic picture of bony pedicle and cartilaginous cap seen in the typical osteochondroma.

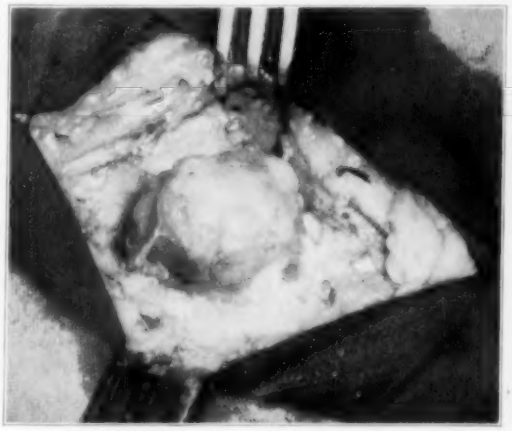

FIG. 2

Operative exposure of osteochondral tumor.

The nature of this tumor is uncertain, presenting as it does several unusual features. It developed in a person between the ages of thirty-six and forty-two years. This is unusual, for the typical osteochondroma arises as the result of some intrinsic growth disturbance and stops growing after closure of the epiphyses.

There was repeated trauma to this area, occurring prior to and coincident with its development. Its site of origin, close to the articular surface of the tibia at a point corresponding to the distal epiphysis during the growth period, is characteristic of the usual osteochondroma.

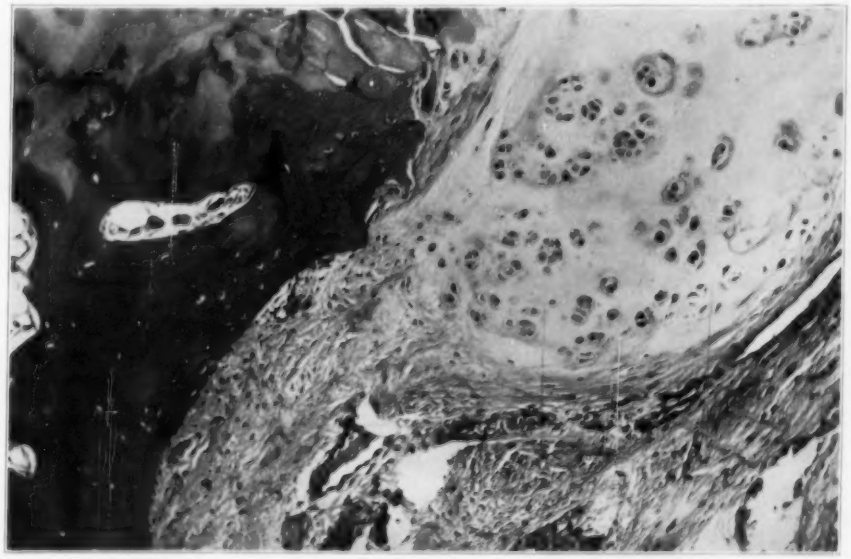

FIG. 3

Photomicrograph of a section taken from excised portion of the tumor, showing bone and cartilage of irregular architecture.

The etiology of this lesion is obscure. It is interesting to speculate on the possible role of trauma in its origin and development. Ossification of a hematoma, with the development of a pseudarthrosis initially or as the result of subsequent injury, is an intriguing possibility.

RUPTURE OF FLEXOR TENDONS, ASSOCIATED WITH A MALUNITED COLLES FRACTURE

BY HAROLD BRODER, M.D., NEW YORK, N. Y.

From Service IV, the Hospital for Joint Diseases, New York

Ruptures of the long extensor tendon to the thumb, and occasionally of the long abductor, have been described in the past as uncommon late sequelae of Colles' fracture[1, 2, 4]. Reports of flexor-tendon ruptures after this injury, however, are virtually unheard of. The author has been unable to find any reference to this entity in the literature.

James reported a case of rupture of the flexor pollicis longus and flexor profundus tendons to the index finger, with partial fraying of the sublimus tendons to the index finger and the profundus to the middle finger, associated with a longstanding Kienböck's disease of the carpal lunate bone.

Spiegel, in 1949, reported a case of flexor-tendon rupture in a patient with an unreduced perilunar dislocation of the wrist.

In the case reported here, massive rupture by attrition of five flexor tendons developed following malunion of a Colles fracture.

CASE REPORT

P. K., aged seventy-one years, an unemployed bus boy, was admitted to the Hospital, complaining of swelling and pain in the region of the right wrist, of four months' duration. Two years before admission, he had suffered a right Colles fracture which had been reduced under local anaesthesia at another institution.

FIG. 1

Roentgenograms made March 18, 1953.

After seven or eight weeks of immobilization in a plaster cast, he had been able to go about his work, free of symptoms. Sixteen months later, he began to lose some power in the right wrist and hand. Soon after this, pain and swelling developed and increased to a degree which forced him to leave his job.

Physical examination revealed a fluctuant soft mass on the palmar aspect of the ulnar side of the right wrist. This measured approximately 3.75 by 5.0 centimeters, extending proximally from the distal wrist crease. Several nodules, approximately one-half a centimeter in diameter, which later turned out to be the proximal ends of the ruptured tendons, were felt to move proximally and distally when motion was attempted. Slight tenderness was present over the mass. Active flexion was absent at the distal interphalangeal joint of the third digit and at both the proximal and distal interphalangeal joints of the fourth and fifth digits. Moderate restriction of wrist motion was present in every direction.

Roentgenograms (Fig. 1) showed a malunited Colles fracture with a volar bony projection and loss of the normal volar tilt of the radiocarpal joint.

At operation the sheath of the common flexor tendon was found to be distended with fluid, and its wall was thickened. The frayed nodular ends of the ruptured sublimus and profundus tendons were found as depicted in Figure 2. The bed in which the tendons were found was smooth. Dorsal to the sheath, the volar bony projection of the distal end of the radius was obvious. There was also a volar displacement of the distal extremity of the ulna.

The following method of repair was chosen: The distal severed ends of the profundus tendons to the third, fourth, and fifth digits were lashed together by means of a silk suture. The common tendon mass formed in this way was then joined to the common profundus motor to the third, fourth, and fifth digits by means of a free graft taken from the sublimus tendon to the fourth digit. The severed sublimus tendons were left unsutured.

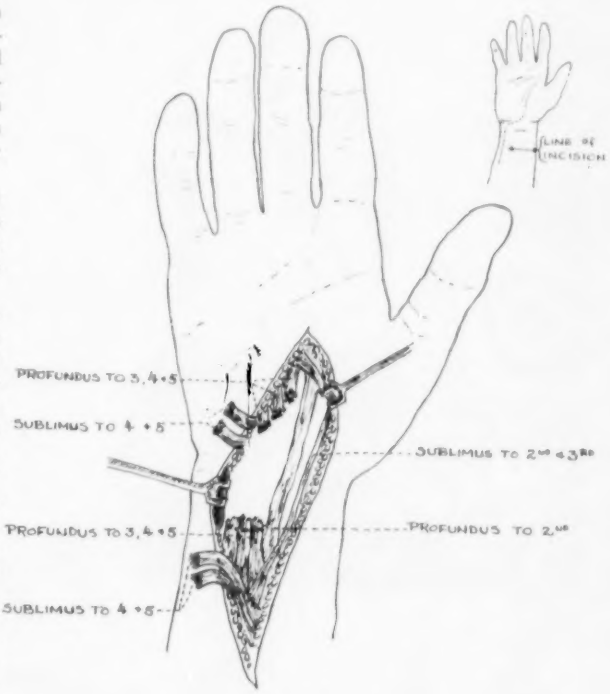

FIG. 2

This was considered, under the circumstances, the most expedient reparative method available for the treatment of a man seventy-one years old. It is not presented as a method of choice for replacing tendons.

Immobilization, with the wrist and fingers in a position of flexion, was maintained for one month following operation. At that time, the patient was able to perform very adequate active flexion of all the phalanges of the involved digits, and the mass had disappeared. When examined three weeks later, he was able to flex the third, fourth, and fifth digits to within one-quarter to one-half inch from the volar surface of the palm.

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OCCLUSION OF THE ULNAR ARTERY WITH IMPENDING GANGRENE OF THE FINGERS RELIEVED BY SECTION OF THE VOLAR CARPAL LIGAMENT

BY BRUCE M. CAMERON, M.D., HOUSTON, TEXAS

A case of occlusion of the ulnar artery at the wrist with secondary impending gangrene of the tips of the third, fourth, and fifth fingers, which was relieved by section of the volar carpal liagment, is reported because of its interest and rarity. No similar case could be found in the literature.

FIG. 1

W. C. J., a seventy-year-old dentist, was seen on October 26, 1951. He complained of severe pain in his right hand. One week prior to being seen, he had noted the insidious onset of tingling, pain, coldness, and cyanosis in the tip of the third finger, and, within forty-eight hours, in the fourth and fifth fingers. The pain had become progressively worse; three days after the onset the pain was excruciating and required the administration of narcotics for its relief. The thumb, forefinger, and opposite hand were uninvolved. There was no history of trauma, excessive smoking, or involvement of the lower extremities; but the patient had noted occasional tingling of the

Fig. 1: Photograph shows the initial involvement of the hand and the areas of cyanosis of the fingers with small areas of demarcation.

Fig. 2: A photograph, taken at the time of operation, shows the compressed area of the ulnar artery after the volar carpal ligament had been sectioned.

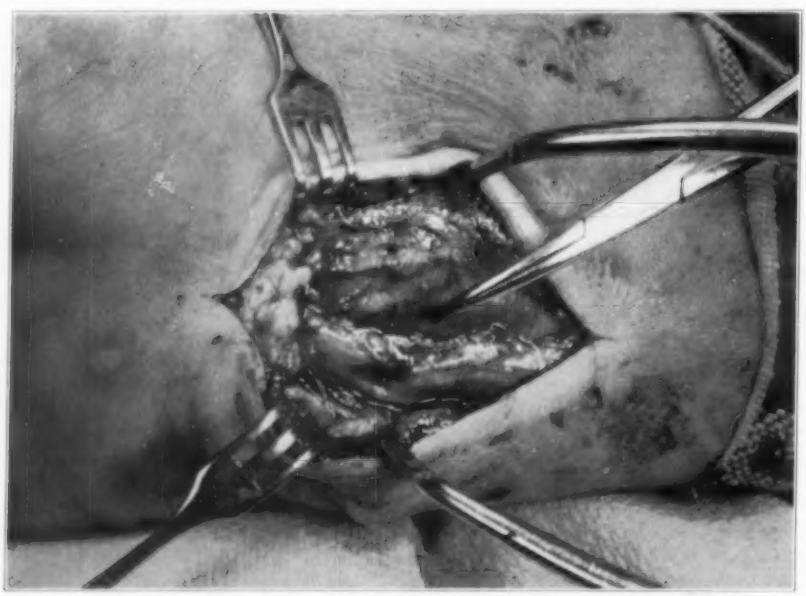

FIG. 2

FIG. 3

FIG. 4

Fig. 3: Three months after surgery, there was marked improvement of the hand. There were shiny areas on the fourth and fifth fingers.

Fig. 4: Thirteen months after surgery, the hand appeared normal.

Fig. 5: The anatomical drawing demonstrates the course of the ulnar artery as it winds its way between the volar carpal ligament and the transverse carpal ligament.

FIG. 5

fingers of both hands in cold weather. He was still active in dentistry, and he used a lathe in his hobby of cabinetmaking.

On examination, it was found that his general health was good. The blood pressure was 150 systolic and 70 diastolic, and there was no evidence of cardiac or generalized peripheral vascular disease. The left upper extremity and the lower extremities were normal. The tips of the third, fourth, and fifth fingers of the right hand were cyanotic, with small areas of demarcation (Fig. 1). Those three fingers and the ulnar side of the hand were cold and tender, and on the areas of cyanosis the tenderness was exquisite. The thumb, index finger, and radial side of the hand were uninvolved. The radial and ulnar arteries were palpable to within one inch of the wrist joint, and the filling time of the veins on the dorsum of the right hand was twelve seconds, as compared with six seconds on the dorsum of the left hand. Compression of the right ulnar artery had no effect on the filling time, but compression of the radial artery blanched the hand and increased the filling time to thirty-five seconds. Roentgenograms failed to demonstrate any abnormalities of soft tissue or bone.

The patient was hospitalized on October 27, 1951, and failed to respond to conservative therapy. On November 1, 1951, the ulnar artery was exposed and was found to be compressed and contused by a heavy band of tissue, presumably the volar carpal ligament (Fig. 2). Arterial pulsation stopped at the area of compression; but, after the contused tissue lying in juxtaposition to the ulnar artery had been removed, hot packs had been applied to the artery for five minutes, and the wall had been injected with 1 per cent. procaine, the pulsation was seen to pass into the distal segment.

After the patient's recovery from anaesthesia, it became evident that the pain had been relieved. The changes in the pulse improved slowly. Three months after operation the fingers were still shiny (Fig. 3). Thirteen months later the appearance of the hand and fingers was normal (Fig. 4).

DISCUSSION

The ulnar artery passes between the volar and the transverse carpal ligaments (Fig. 5), and in this case it was compressed between the two. Either one or both of the ligaments could have compressed the ulnar artery at this point, and the compression could have been relieved by sectioning the volar carpal ligament. It is well known that the transverse carpal ligament can compress the median nerve [1,2,3]; and Watson-Jones reported a case of Léri's pleonosteosis in which the ligament actually had become thickened. Phalen and his associates reported that, in one of their four cases of neuropathy of the median nerve due to compression by the transverse carpal ligament, de Quervain's syndrome was associated with the compression. This suggests that the fibrous tissue around the wrist has a tendency to hypertrophy and to thicken, with secondary compression of the underlying structures.

The failure of the collateral circulation of the hand to compensate for the occluded artery is not understood. It can only be suggested that the distal ulnar segments of this artery might have been in spasm and that the spasm was subsequently relieved. This patient understood prior to surgery that, if the exploration of the ulnar artery failed, a cervical sympathectomy would be required; the simplicity of the procedure used and the result justified the course adopted.

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AN INEXPENSIVE STATIONARY BICYCLE

BY G. EDMUND HAGGART, M.D., BOSTON, MASSACHUSETTS

From the Department of Orthopaedic Surgery, The Lahey Clinic, Boston

The accompanying photograph illustrates how the standard girl's bicycle may be transformed into a very efficient stationary bicycle. When the patient no longer needs the machine for exercises, the bicycle may easily be restored to its original function.

It is to be noted that the original model does not have to be greatly altered. The rear fender is removed so as not to interfere with the brake making contact with the tire. It is not necessary to remove the front wheel, but, if this is done, the resulting machine takes less room and is easier to move from one place to another by up-ending the front and pushing it around on the rear wheel. If the front wheel is removed, the axle which came with this wheel is utilized and, with two extra nuts and washers, the front wheel fork is attached to the frame, as illustrated in the photograph.

The frame for this bicycle was designed by Mr. Ronald S. Newell of Newport, New Hampshire, and the blueprints * were drawn up by Mr. Richard Jordan of Waverley, Pennsylvania. In their opinion, the cost of materials would not exceed ten dollars, and they estimate fifteen hours as the time required to make up the frame and attach it to the bicycle. As they further point out, dismantling the frame is a simple manoeuvre and then, with the front wheel again in place and the fenders on, the bicycle is once more ready for use in the customary manner.

FIG. 1

Patients, convalescing from hip or knee operations, for whom the bicycle is particularly indicated to improve joint function and to develop strength and tone in the musculature of the lower extremities, find after leaving the hospital that their progress is delayed when they do not have a stationary bicycle. To purchase such a machine, available in surgical supply houses, is costly and, once the need for it has passed, it remains a stationary bicycle. With the adaptation illustrated here, the cost is comparatively small and the bicycle can then be restored to its former function.

Another point should be mentioned,—namely, that for a large individual the average stationary bicycle is not as stable as might be desired. The patient for whom this bicycle was made is a large man, and while he was in the hospital he was afraid that the machine would tip over as he made initial efforts to ride it. The wide base of this frame gives marked stability.

* Blueprints showing details of construction may be obtained from Ronald S. Newell, Newport, New Hampshire.

A RECIPROCATING TWIN OSTEOTOME

BY VINCENT E. LEGGIADRO, M.D., PORT CHESTER, NEW YORK

All types of osteotomies of the superficial bones are now performed with speed, precision, and safety because of the oscillating movement of the cutting instrument which has taken the place of the rotatory high-speed saw. The problem of osteotomy of deep-seated bones, such as the femur, has been partially solved by a more convenient approach. In July 1948, the author published a description [1] of a guide drill for osteotomy of the femur and a method for severing deep bones with contiguous drill holes, which leaves no web between them. To facilitate the surgical procedure, a new reciprocating

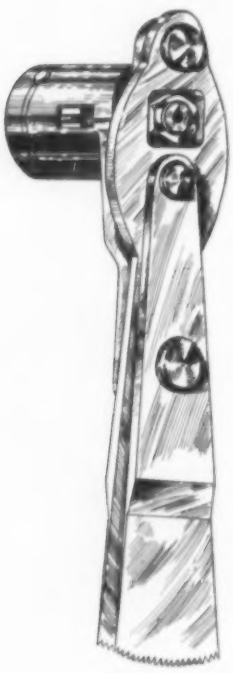

FIG. 1

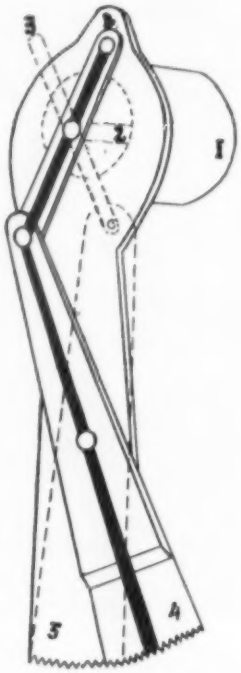

FIG. 2-A

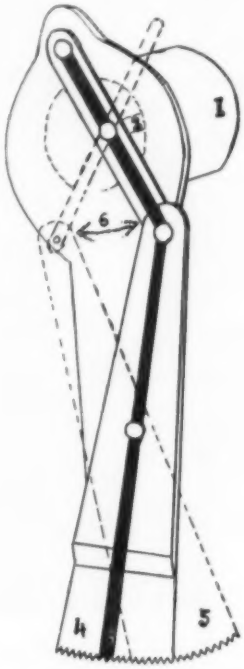

FIG. 2-B

Fig. 1: Drawing shows the new reciprocating twin osteotome.

Fig. 2-A: In this schematic drawing of the reciprocating twin osteotome are shown: *1* housing, *2* arbor, *3* cam, *4* anterior blade moved to the right, and *5* posterior blade moved to the left.

Fig. 2-B: In this drawing the anterior blade is shown moved to the left and the posterior blade is shown moved to the right. The stroke distance is shown (*6*).

osteotome (Fig. 1) has been developed which has been found to be even more efficient.

Figures 2-A and 2-B show two blades with serrated ends. They are firmly attached to the arbor which transmits the oscillating or reciprocating action of the motor. The moving blades work in opposite directions. This counteraction prevents any loss of stroke and firmly stabilizes the bone to be severed. The osteotome is seven inches long, its size permitting greater facility and control in use. It can be attached to any of the standard oscillating motors in general use today.

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To the Editor:

For the past two years, the Joint Committee for the Study of Surgical Materials has been hard at work. Our report should be of interest to all orthopaedic surgeons, and we would be grateful if you would publish it in this slightly abbreviated form. The proposed American Surgical Materials Association has not yet come into being. We hope that our report will serve to outline the magnitude of the problem and will be the basis for appropriate action.

Very sincerely yours,

March 1, 1954 *Joseph S. Barr, M.D.*

REPORT OF THE JOINT COMMITTEE FOR THE STUDY OF SURGICAL MATERIALS

(Condensed)

Introduction

Surgeons are making increasing use of materials which they implant in the human body. There is a growing realization that the surgeon needs to have far better knowledge than he now has of the characteristics of the materials he uses. Discussion of this need was stimulated by the Presidential Address of Dr. Joseph S. Barr before The American Academy of Orthopaedic Surgeons, in January 1952, which he devoted to the problem.

The American Academy of Orthopaedic Surgeons approached the American College of Surgeons and the American Medical Association with the suggestion that a joint committee of the three organizations be set up for a preliminary study of the matter. The suggestion met with favor, and such a committee was set up in the Spring of 1952 under the name of the Joint Committee for the Study of Surgical Materials.

After preliminary study, the Committee came to the conclusion that there is need of some form of a permanent organization whose primary functions should be:

1. To test or to cause to be tested surgical materials and devices and to issue certificates giving specified data concerning the mechanical and biological properties of the articles tested;
2. To conduct and encourage research and to disseminate knowledge in the broad field of surgical engineering;
3. To encourage such standardization of sizes and types of devices as may be in the best interests of the surgical patient;
4. To assist manufacturers in their efforts to produce better surgical materials at decreased cost.

The Committee recommended to its three sponsors, The American Academy of Orthopaedic Surgeons, the American College of Surgeons, and the American Medical Association, that such a body be set up and that each of the three sponsors should appropriate the sum of $4,000 to enable the Committee to make the necessary studies and to prepare the organizational plan.

All three sponsors approved the undertaking and appropriated the funds requested.

This enabled the Committee to proceed with the project in the Spring of 1953. The Committee engaged the services of Dr. P. G. Agnew to make a broad survey of the field and to assist the Committee in preparing its report and recommendations.

The survey has included over a hundred interviews with surgeons, manufacturers of basic materials, fabricators of devices for use as implants, manufacturers of sutures, hospital officials, Government agencies, and philanthropic foundations.

Survey Data and Notes

Materials

The materials included in the proposed project fall into three groups:

1. Metals, such as stainless steel, tantalum, titanium, and Vitallium;
2. Plastics, such as acrylic, nylon, polyethylene, polyvinyl formal, and vinyon-N;
3. Sutures made of such materials as catgut, cotton, metal, nylon, and silk.

The Groups Concerned

Medical Groups: The approximate membership of the three medical groups sponsoring the Joint Committee is as follows:

The American Academy of Orthopaedic Surgeons	1,797
American College of Surgeons	18,500
American Medical Association	130,000

There is considerable overlap in membership in these three groups. The surgical specialty groups have not been included, as their membership is duplicated in these three societies.

Hospital Groups: The principal hospital groups interested are:

American Hospital Association
Hospital Bureau of Standards and Supplies

The American Hospital Association is the national organization of hospitals. Through the Hospital Bureau of Standards and Supplies, 300 hospitals do cooperative purchasing, carry on technical research and testing, and exchange information on purchasing.

Basic Material Manufacturers: The greater part of the stainless steel used in implants is produced by five large manufacturers. Only an extremely small fraction of the total output of stainless steel is used in surgical materials. Likewise, most of the basic plastic materials used in implants is produced by five large chemical manufacturers. The amount of plastics used in implants is an extremely small part of the output of plastics for industrial use.

Processors and Fabricators: The basic materials are used by processors and fabricators. Estimates of the annual sales of the three groups of fabricators of materials and devices used as implants are as follows:

Surgical sutures	$20,000,000
Surgical "hardware"	3,000,000
Surgical plastics	not available.

The suture industry is the oldest and the most highly developed of the three. The large suture manufacturers carry on extensive research work, including the testing of their sutures in animals.

There are six or seven relatively small manufacturers of surgical metallic implants, the majority of whom are not in a position to carry on research work. Most of the metallic implants are used in internal fixation of fractures and in orthopaedic surgery.

Fabricators of plastic materials and devices are also small companies and most of them do not have facilities for research work. They are the youngest of the three fabricating industries.

Trade Associations: There are a number of trade and industrial associations which may have an interest in this project:

Manufacturers Surgical Trade Association: This Association has about seventy members, including manufacturers of surgical instruments and equipment. (The value of the annual output of the entire industry is about $350,000,000. Less than 2 per cent. of this amount comes from implants.) Only a small minority of implant fabricators are members of the Association.

American Surgical Trade Association: The membership consists of 260 dealers who sell to hospitals and surgeons.

Manufacturing Chemists Association: All five of the large plastics manufacturers are members of the Plastics Department of the Association.

Society of the Plastics Industry: This is a technical society which has some of the characteristics of a trade association.

American Iron and Steel Institute: All five of the large manufacturers of stainless steel are members of the Institute's stainless-steel group.

Association of Casualty and Surety Companies: The membership of this association includes a number of companies which write medical liability insurance, including two of the three companies which write the greater part of such insurance.

There was formerly a Surgical Suture Manufacturers Association, but this has now been dissolved.

Similar Plans Now in Operation

There are a few undertakings, similar in plan, which have been in operation for some time and the experience gained from these undertakings provides a valuable guide.

The Dental Materials Project

The Dental Materials Project includes research, testing, and evaluation of dental materials. It is carried on cooperatively by the American Dental Association and the National Bureau of Standards. The research and testing include physical, chemical, and biological methods. The physical and chemical work is done at the National Bureau of Standards, and the biological work is done at the National Institute of Dental Health.

A systematic procedure is followed in developing and revising specifications for materials. Formal approval of such standards is by the Board of Trustees of the American Dental Association.

To secure acceptance of a product, a manufacturer must have some form of quality control. Samples for testing are selected at random. Other samples are purchased on the open market. Formal acceptance is by vote of the Board of Trustees of the American Dental Association. When accepted, a product is placed upon the published list.

In its twenty-five years of operation, this work has had a profound influence in bringing about improvements in practically the whole range of dental materials. In all, 176 papers have been published on various aspects of the subject.

American Medical Association

The work of the American Medical Association which most closely resembles the project of the Joint Committee is that of four scientific Councils:

Council on Pharmacy and Chemistry

Council on Physical Medicine and Rehabilitation
Council on Food and Nutrition
Committee on Cosmetics

The work of these Councils is buttressed by a chemical laboratory and a physical laboratory.

The methods of operation of the four Councils are very similar. Each Council maintains its own standards and publishes its own list of accepted products. Each Council has a group of advisory committees and in special fields may use the services of a "referee". Approval of standards and acceptance of products are by vote of the Council concerned. Upon approval of a product, use of the Council's seal is granted.

The accepted list of the Council on Pharmacy and Chemistry is the well known *New and Nonofficial Remedies*.

Claims for the product on the label or in advertising must be kept within the factual findings of the Council accepting the product, or the acceptance is withdrawn.

The expense of the work of these Councils is borne entirely from the regular budget of the American Medical Association. This point is emphasized to make clear to the public the complete independence of the American Medical Association in accepting products.

The United States Food and Drug Administration

The chief function of the Food and Drug Administration is the enforcement of the Food, Drug, and Cosmetic Act. It establishes standards for purity of foods, and it enforces the standards for drugs as specified by the United States Pharmacopoeia. The operations of the United States Food and Drug Administration center largely around those products which are adulterated, misbranded, or dangerous to health. Its jurisdiction extends only to products which move in interstate commerce.

Under the terms of the present laws, the scope of the Food and Drug Administration has been greatly broadened. It includes "devices" which are defined as follows in the law:

> "The term 'device' . . . means instruments, apparatus, and contrivances, including their components, parts, and accessories, intended (1) for use in the diagnosis, cure, mitigation, treatment, or prevention of disease in man or other animals; or (2) to affect the structure or any function of the body of man or other animal." *Public Law No. 717, Sec. 201(h).*

The methods used by the Food and Drug Administration are well illustrated by an actual case. Complaints were received that a certain product did not have the strength indicated on the label. The Food and Drug Administration made an investigation and found that some of the product on the market had less than half of the strength shown on the label. These were all traced to a single manufacturer. This manufacturer was found to have faulty production methods and his factory to be without adequate control of quality. The manufacturer was "cited", that is, he was officially, but not publicly, charged with mislabeling.

He is now being given time to improve his product, at the end of which new tests will be made. If the product is then found to be mislabeled, the Food and Drug Administration will have three legal courses open to it:

1. Mislabeled packages of the product may be "seized", and either destroyed or sold for salvage purposes;
2. The manufacturer may be prosecuted in the courts on a criminal offense;
3. The Food and Drug Administration may seek to have him enjoined in the courts, but this method is seldom used.

It is obvious that surgical implants are "devices" under the present law and thus come within the scope of the Food and Drug Administration. However, this will in no way interfere with the objective of the Joint Committee. Before the Food and Drug Administration can determine whether a product is correctly labeled, an adequate standard has to be available with which the product can be measured or tested. For most implants, no such standards now exist. The work of the Food and Drug Administration will thus be facilitated by the setting up of adequate standards. This is clearly seen to be true in the analagous cases of the American Medical Association Councils and the Dental Materials Project, in which sound technical standards are being set up, standards which become immediately available to the Food and Drug Administration for use in determining whether a product is mislabeled.

We have been assured by representatives of the Food and Drug Administration that they will welcome the program of the Joint Committee which, they are confident, will facilitate their work.

United States Pharmacopoeia

The United States Pharmacopoeia is essentially a large group of compact specifications for drugs and related products. These specifications have the force of law, and are administered by the United States Food and Drug Administration. The Pharmacopoeia is under constant revision. Interim revisions and supplements are issued from time to time and an entirely new book is issued every five years. The revisions are made by subcommittees operating under a General Committee on Revision elected by the United States Pharmacopoeial Convention.

The United States Pharmacopoeia now contains specifications for surgical sutures, oxidized cellulose,

absorbable gelatin sponge, absorbent gauze, and adhesive plaster. Specifications have been formulated for disposable transfusion assemblies,—a subject which is also under study by the International Organization for Standardization. American participation in the latter is handled through the American Standards Association.

We have been assured by a representative of the Pharmacopoeia that they will welcome the cooperation of the proposed new organization, whose work they believe will be mutually beneficial.

The Advisory Committee on Artificial Limbs

The Advisory Committee on Artificial Limbs functions under the National Research Council, and it is financed by the Veterans Administration. The work of the Advisory Committee has had a great educational effect upon both surgeons and the artificial limbs industry (which had been a father-to-son industry).

One of its research reports contains data basic in the use of orthopaedic implants: *Fundamental Studies of Human Locomotion, Including Forces, Velocities, and Accelerations; Muscle Action in the Leg.* (Available at the Army Medical Library, 7th and Independence Avenue, S.W., Washington, D. C., in microfilm or photostat form.)

The American Standards Association

The American Standards Association is a federation of over a hundred associations. It works primarily in the field of industrial standards, and its financial support is entirely from private industry. It functions as a "clearinghouse . . . for industry, insurance, State and Federal Governments". The individual states have largely based their state safety regulations on standards agreed upon by means of this clearinghouse technique. Examples of standards in the field of medicine which have been set up are:

1. Standards on toxic limits (there are now eighteen such standards);
2. Standards for audiometers;
3. A standard to prevent the accidental switching of gas containers on anaesthetic machines;
4. Standards for noise in industrial plants (in process).

Underwriters Laboratories

The large testing laboratory of Underwriters Laboratories is owned by the National Board of Fire Underwriters, but it operates on a non-profit basis. Its work is supported by fees for testing, which it endeavors to keep low enough so as not to increase the cost of the product significantly. Its primary concern is with testing which has a bearing upon insurance problems. The Laboratories "approve" products upon the basis of standards and the judgment of the engineering staff. The work now includes some lines of hospital equipment.

Better Control of Materials Needed

There is evidence on every hand that the surgeon needs better materials and better control of his materials. Biological compatibility is a basic requirement of all such materials.

Metals

The surgeon needs to be sure that the metal parts he uses in combination are of the same composition and do not differ too greatly in heat treatment and cold working, lest they corrode.

There are over fifty commercial grades of stainless steel. The engineering vice-president of a steel company reports that an aircraft manufacturer has better control of the stainless-steel parts he uses than surgeons have over their implants. Some fabricators are not precise enough in placing orders. An order which merely specifies "18-8-SMo steel" might be filled by any one of the four standard grades of the American Iron and Steel Institute. He thinks the literature should be critically reviewed and the experimental work upon which present practice is based should be repeated under better controlled conditions.

Tantalum mesh is reported to break often from metallic fatigue. It is believed that this generally does no damage because of the growth of supporting tissue.

Titanium, a light metal, is a promising substitute for stainless steel. While the industry is preoccupied with the urgent need of increased production for use in National Defense, it offers its cooperation in studying the problems involved in the use of titanium for implants in the human body.

Vitallium, a non-ferrous alloy, is in common use as implant material.

The relative merits of stainless steel, Vitallium, and other metals and alloys are not clearly defined.

Plastics

It is not possible to control the composition of plastics so precisely as it is possible with simpler substances. Moreover, in order to facilitate the process of fabrication, plasticizers and other chemicals are often added to the plastic. This may lead to tissue reaction. Unfortunately some fabricators do not apply the necessary precautions to maintain the purity of the plastic throughout, and most fabricators do not give sufficient information on their labels. However, one wholesaler has each lot of polyethylene tubing tested in animals before releasing it for sale, and one fabricator has his intravenous and plastic spinal tubing tested in animals.

Sutures

The suture industry is an old one and is fairly highly developed. The United States Pharmacopoeia has for years contained a specification for sutures. Criticisms have been made both by surgeons and by manufacturers, indicating that this specification needs revision and, in particular, that some of the requirements should be made more rigorous.

Foreign-Body Reaction (The Need of Standard Method of Measurement)

The central problem of biological compatibility is discussed on every hand. It has been suggested that a particularly important job for the new organization is to develop methods of measuring foreign-body reaction and to set up minimum requirements for the study of new materials.

The Engineering Approach

There is universal agreement that both the surgeon and the fabricator need to make much more extensive use of engineering methods in their work. (We take note of this fact in our recommendations later in this report.)

An example which is frequently pointed out is that nicks or notches should be scrupulously avoided because they serve as incipient cracks. "The edges of bone plates, nails, and other structural devices should never have a sharp edge because such sharp edges are apt to have hair cracks in them, which concentrate stress and may thus lead to failure. All edges of such elements should be carefully rounded to avoid this danger of weakness." Even slight corrosion causes pitting which acts as a nick. As another example, alternating stresses may be cited which cause "fatigue" and failure if the part has not been properly designed. Many implants, both metal and plastic, have broken from this cause.

Statistical Quality Control

In the last dozen years, nearly all large industries have introduced what is known as statistical quality control in their processes of production. Formerly, factory-inspection methods were simple and crude. Samples of the product were tested for conformity with the limits laid down in the specification and were either accepted or rejected. Under the new method, each sample is measured to determine how far it falls inside or outside the specified limits. The results, when analyzed statistically, generally enable the production engineer to put his finger upon a developing trouble spot and to correct it before actual trouble occurs.

The new method has enabled manufacturers to increase greatly the accuracy of their production. The United States Department of Defense requires its contractors to use the method for a considerable number of products, and has, thereby, been able to make large savings in the cost of inspection. (In the drafting of Rules for the Acceptance of Products, we have provided that due credit be given manufacturers who maintain a statistical quality control system.)

The staff of the new organization will have to be thoroughly familiar with the method, and should, therefore, be able to render advisory assistance to fabricators who do not already use the method in installing it.

Digests of the Literature

It has frequently been suggested that one of the first activities of the new organization should be the preparation and publication of digests of the existing literature. Most believe that these digests should be critical, each in its own field, and that the digests should make clear those points upon which confirmatory work is needed before general acceptance. The digests also should point out what yet needs to be done in research.

Bibliographies: In connection with the preparation of digests, bibliographies will have to be compiled.

Bio Sciences Information Exchange is a clearinghouse of information on research projects in the whole medical field. It is supported by the seven Government agencies which make grants for medical research, and its work covers all grants for medical research made by the National Government and, also, all grants made by sixty private foundations. All of the research projects covered are classified according to subject, supporting agency, chief investigator, and the research institution in which the work is done. During 1952, Government grants totaled $34,500,000 and private agencies $12,900,000, making a total of $47,400,000. The average grant is about $10,000 per year. This amount has been increasing since 1946; 55 per cent. of the grants are now between $5,000 and $20,000. Most of the grants are continued for a number of years.

The Exchange has very kindly prepared for the Joint Committee a list of current grants for research having to do with implanted materials.

Flow of Information

The opinion has frequently been expressed that the value of the organization to the profession and to industry will depend largely upon the effectiveness with which it makes information on the whole subject available to all concerned,—for example, by issuing pamphlets and by releasing information to professional journals.

Damage Suits and Insurance Premiums

The question has been raised a number of times concerning the effect which a set of standards for surgical materials might have upon damage suits against surgeons, hospitals, and manufacturers, and upon the rising costs of medical insurance. The vice-president of a large insurance company states that for the past ten years the number of damage suits against surgeons and against hospitals has been steadily increasing. Likewise, the amount of the awards made by the courts has been steadily increasing. Both surgeons and hospitals are now extremely vulnerable to damage suits, because there are now no generally recognized standards. If these trends continue, he believes that many young surgeons will not be able to afford insurance coverage, since both of these trends necessarily mean higher premiums. He was much surprised to learn that such an organization as that which we contemplate is not already in existence.

The experience of the American Standards Association throws some light on the relation of standards to damage suits. Some 200 American Safety Standards have been developed through the all-parties-at-interest procedure of the American Standards Association. These standards now form the backbone of the regulations of the various state governments for the protection of workmen. In several cases, courts have held that compliance with these standards is *prima facie* evidence of compliance with current good practice. In a recent New Jersey case, involving the use of x-rays in testing steel parts, both Trial Court and Superior Court have so held. In fact, several hundred city ordinances and three or four state laws have given the American Electric Safety Standards the legal status of *prima facie* evidence of good practice.

The use of current practice as a criterion by which to judge cases is a cardinal principle of the English Common Law upon which our legal system is based. A set of sound standards should afford considerable protection to surgeons, hospitals, and manufacturers against unjustified damage suits.

Miscellaneous Notes

Glove Powders: It is reported that, although surgeons are generally aware of the fact that the old-fashioned talc used on surgeons' gloves caused granulomata and adhesions, the old talc is still being used. Some hospitals are mixing the old talc with the modern absorbable glove powder in order to lower costs. Unfortunately, surgeons may be unaware of this practice.

Dental Implants: A small number of dentists have been experimenting with metal implants placed in the jaw bone and to which the denture is attached. This procedure is followed only in very difficult cases. The dentists interested have formed a small technical organization called the American Academy of Implant Dentures.

Use of Present Information on Labels and on Patients' Records: It has been proposed that one of the first acts of the new organization should be to encourage manufacturers to label each item or package with such information as composition, heat treatment, cold working, and size for general guidance. This can be done right away before any attempt is made to set up standards. It would pave the way for standards and would make their adoption easier. The data on such a labeled package should be entered upon the patient's record. This would be useful in checking possible future trouble; it would also be useful for statistical purposes.

What Functions Should the New Organization Perform?

As indicated in the previous section, a variety of functions have been suggested for the new organization. The more important of these are research, development of standards, testing and evaluation of products, patents, and providing an active information service.

Research

Should the organization attempt to do basic research work itself, perhaps in its own laboratory? Should it finance research? Should it limit itself, at least at first, to stimulating such research on the part of other groups? The cost of financing the necessary research would almost certainly be beyond the resources of the young organization; and it would not be possible for a small staff to carry on the necessary research work in so many diverse fields.

Recommendation: It is recommended that the organization limit itself, at least for the present, to stimulating other groups to do basic research work by systematically pointing out the gaps in our knowledge which need to be filled. This can be done:

1. In committee reports;
2. In articles in professional journals;
3. By correspondence with
   - Medical schools,
   - Hospitals,
   - Research laboratories,
   - Private and Government medical agencies.

Standards

There is complete agreement that the development of standards should be a basic function of the

organization. The collaboration of the American Standards Association and the National Bureau of Standards should be requested and fostered.

Recommendation: It is recommended that the organization have as a primary function the development, revision, and approval of the following types of standards:

1. Nomenclature;
2. Methods of test;
3. Specifications for materials and devices;
4. Dimensional standards.

It is further recommended that the personnel of each technical committee dealing with standards include representatives of those groups which have a substantial and legitimate concern with the scope and subject matter of the standards with which the committee is dealing, thus complying with the "all-parties-at-interest procedure" of the American Standards Association.

The last provision will make it possible for the organization's standards to be designated semi-automatically as "American Standards" by the American Standards Association.

Such an arrangement will have the advantage of making the experience and contacts of the American Standards Association, and of the many industries and technical groups associated with it, available to the organization. It will also make available, through the American Standards Association, cooperative contact with the International Organization for Standardization and the national standards bodies of thirty foreign countries.

These suggestions are the basis of the accompanying "Procedure for the Development and Approval of Standards".

Testing

There is unanimous agreement that the organization will have to engage in some testing activities, mostly in connection with the evaluation of products and their acceptance. Most testing will probably be in laboratories on a compensation basis. There will probably be a small amount of testing for technical committees doing standards work.

Four kinds of testing will be involved: physical, animal, chemical, and clinical.

Clinical trials will generally be carried out on a cooperative basis by medical schools and hospitals.

Manufacturers will be responsible for arranging for such physical, chemical, animal, and clinical testing as is necessary to provide them with data for use in submitting their products for acceptance.

Yet if the new organization is to evaluate specific products, it will have to arrange for a considerable amount of check testing in many diverse fields, including the testing of products purchased on the open market.

Recommendation: It is recommended that, at least at first, all necessary testing be arranged for on a cooperative or a compensation basis, rather than by setting up a special laboratory.

Evaluation of Products

All of the functions of the organization must be directed toward helping the surgeon to select the device or material which is best fitted for each particular operation which he has to perform. Evaluation of products available for his use thus form the last link—and an essential link—in the chain of activities of the organization.

The word "certification" is often used to describe this whole process. As has been noted previously, the American Medical Association and the American Dental Association use a somewhat different nomenclature. They officially "accept" products which, after careful scrutiny and testing, they find to comply with their specifications and other requirements. Acceptance of products is announced in the professional journals, and the products are listed in published lists of such approved products.

This arrangement thus becomes a powerful aid to physicians and dentists in selecting products suitable for their use.

A small minority have suggested that, because of the great care with which the process has to be carried out, the new organization wait until it has had a year or two of experience before setting up an acceptance plan. But the great majority, believing it to be an essential step, think the organization should start preparing for it immediately with great care.

Normally, consideration of a product will be initiated by a request of the manufacturer. He will outline his claims for the product and will submit supporting evidence in the form of the results of physical, chemical, and animal tests, and clinical trials, including published data. The matter will be referred to a technical committee for investigation and for the preparation of a report on the product. Check tests will be made upon samples purchased in the open market.

The Technical Committee's report will go to the Board of Directors for action. To avoid embarrassment to those members of the Board who are manufacturers, or employees of the Federal Government, such members will not vote upon the acceptance of products.

Labels will be examined for accuracy, and the manufacturer will be requested to keep his advertising conservative.

Recommendation: It is recommended that the new organization treat the evaluation of products as one of its basic functions, and prepare for the formal acceptance of such products as meet its standards. This should include the adoption of a seal, the use of which will be permitted in the marketing of accepted products. (See the accompanying draft Rules for the Acceptance of Products.)

Patents

Opinion is sharply divided as to whether such an organization ought to own or to take out patents.

Recommendation: It is recommended that the organization, at least for the present, take no action either for or against the ownership of patents.

Information Services

The importance of gathering and disseminating information should be stressed. Properly carried out, it can greatly increase the usefulness of the organization and help in easing the financial burden.

Consider, for example, the serious lack of statistical information on clinical experience with implants of various kinds. The new organization should form systematic plans to fill this gap, making it a cooperative undertaking in which hospitals, private and governmental, would play a leading role.

Consider again the question of preparing digests of the literature. The field should be broken down into limited subjects, for example:

Cotton sutures	Glove powders
Silk sutures	Plastic tubing
Stainless steels	Titanium

Each of these digests should be critically reviewed by a technical committee, with emphasis on results which need confirmation and on gaps in knowledge which need to be filled by further research. The digest would then be published. Thus treated, the digests would stimulate research, and they would provide a point of departure for much of the technical work of the organization.

These two activities well illustrate the great educational service which the organization could render in its capacity as a bureau of information.

Recommendation: It is recommended that the providing of an effective information service in the whole field of surgical materials be made a basic function of the new organization.

What Should Be the Form of Organization?

Any one of a number of forms of organization might be used. For example, the undertaking could be operated through a self-perpetuating board

As a branch of the American Medical Association;

As a branch of the American College of Surgeons;

As a joint committee of these two organizations together with The American Academy of Orthopaedic Surgeons;

As a cooperative organization of all the groups directly interested, including the American Hospital Association, manufacturers, and Government agencies, on either an official or an informal basis.

Obviously each form of organization has both advantages and disadvantages. We believe, however, that the undertaking will be more successful if the organization is a democratic one, so that each group has a sense of participation.

Recommendation: It is recommended that the undertaking be set up as a cooperative organization of all groups directly interested, with general authority and management to be centered in the Board of Directors.

There will be three classes of members:

Member Bodies: These would be professional societies, trade associations, and Government agencies. They would constitute the basic membership. Charter members would include the American Medical Association, the American College of Surgeons, The American Academy of Orthopaedic Surgeons, and the American Hospital Association.

Member Companies: These would be interested companies, cooperating in the work and in the support of the organization.

Associate Members: This class of membership would include hospitals, educational and research institutions, and individuals. (No attempt should be made to build a large individual membership. The intent is merely to provide a means of welcoming the few individuals who would like to have a direct affiliation.)

In the case of industries which are cooperating directly instead of through an association, it will often

be advantageous to arrange for a small informal committee composed of representatives of the industries in order to facilitate cooperation.

Technical and Executive Levels

Most of the work would be done through technical committees. There would probably be three standing technical committees: on metals, on plastics, and on sutures.

Board of Directors

General administration and authority would be centered in a Board of Directors.

That such a form of organization can be very flexible is readily seen by considering how the Board of Directors would be made up. The Board might contain about 20 members, for example:

Medical Representatives:		
American Medical Association	2	
American College of Surgeons	2	
The American Academy of Orthopaedic Surgeons	2	
American Hospital Association	2	
		8
Manufacturers:		
Metals	1	
Plastics	1	
		2
Fabricators:		
Metals	3	
Plastics	1	
Sutures	1	
		5
Insurance:		1
Members-at-large:		
Engineers	2	
Individuals connected with Government	3	
		5
Total		21

Directors representing Member Bodies would be appointed by the Member Bodies.

Members-at-large would be elected by the Board.

All directors would serve three-year terms, after the first year.

Location

The following suggestions have been made for the location of the organization:

At the American Medical Association Headquarters;

At the American College of Surgeons;

At a Government laboratory, such as the National Bureau of Standards;

At a large research center, such as Massachusetts Institute of Technology or Mellon Institute;

In a separate office.

Recommendation: It is recommended that the new organization be located with or adjacent to the headquarters of the American College of Surgeons.

The job is, first and last, a surgical matter; and it is, therefore, fitting that the organization be housed with that which represents all surgeons.

There are a number of operating advantages in such an arrangement, including the use of the library of the American College of Surgeons and the proximity of the American Medical Association headquarters. Such proximity will make it easy to consult with the American College of Surgeons and American Medical Association staffs, and to draw on their experience.

Chicago is a great medical center and a great engineering center.

Name

The name should clearly indicate the organization's field of work. Practically, this means that the name must contain the words "Surgical Materials".

The name should indicate that the scope of the organization is national. Either "American" or "National" would do this, whereas the word "Joint" would not do it so clearly.

Some such word as "Association", "Committee", or "Council" must be included in the name.

We thus have the choice of any combination of the following:

		Alliance
		Assembly
		Association
American		Board
		Chamber
		Commission
Joint	Surgical Materials	Confederation
		Conference
		Council
National		Federation
		Institute
		League
		Society
		Union

Other variations are possible by placing the word chosen from the last column in second place, thus: "American Association for Surgical Materials" or "American Surgical Materials Association".

Recommendation: We recommend *American Surgical Materials Association* (*ASMA*) as being concise, accurate, and, we believe, most suitable for the purpose.

At this time, there seems to be some advantage in a name the initials of which trip lightly off the tongue. The letters ASMA do so.

Financing

Suggestions have been made that the undertaking should be financed

By the medical profession;
By industry;
By grants from foundations;
By Government;
By fees for testing;
By patent royalties.

We recommend that the medical profession and industry join in the financing, and that foundations and Government agencies be requested to make supplementary grants for specific purposes.

Two or three have raised the question of whether it would not be well to forego support from manufacturers in order to avoid any possibility of the propriety of doing so being questioned on the ground that the organization would be evaluating the products of manufacturers. We agree with the large majority that any such danger is so exceedingly slight that it may safely be ignored, especially so since all receipts will be merged into a single fund, and manufacturers will have no voice in the acceptance of products.

Informal discussions with foundations have made it clear that the sound way of proceeding is for the profession and industry to provide their fair share of support, thus showing their faith in the project. Should it then be found that more is needed to fulfill our obligations to the public, it will be much easier to secure support from foundations.

It is believed that practically all of the work of the organization will be of direct value to the great medical agencies of the Government, including the Food and Drug Administration, the Public Health Service, the Surgeons-General of the Defense Department, and the Chief Medical Director of the Veterans Administration. Hence, there should be close cooperation with Government agencies on the technical level. It is also believed that the Government agencies will be willing to support research work needed by the surgical profession and the organization, provided it will be of value to the Government.

Groups participating in the undertaking should be asked to continue their financial support for at least three years, without, however, legal commitment. During the second and third years, there should be a complete re-study of the financial structure, so that any desirable changes may be introduced at the beginning of the fourth year.

It is hoped that ultimately revenue from sale of publications, seals of acceptance, and other sources will substantially decrease the need for financial support from the charter member bodies.

Special Problems

Engineering Principles

It is universally recognized that engineering principles should be used much more extensively in the design and use of prosthetic devices and other implants. (The word engineering is here used to include metallurgical, physical, and chemical principles.)

Our *recommendations* include three measures to aid in bringing this about:

1. Requiring that two members of the Board of Directors shall have had engineering training and experience;

2. That normally each technical committee contain at least one engineer;
3. That engineering talent and experience be represented in the staff.

Staff

Because of the complicated problems with which the organization will have to deal, the demands upon the staff will be unusually exacting. This will be particularly true in the case of the head of the staff; not only will he have to deal with the usual problems of administration, public relations, and financing, but he will have to deal with medical, engineering, and research problems.

At first the staff should be kept small, consisting of perhaps only two key men, with supporting clerical personnel. This will be in keeping with a modest start for the organization. However, only really high-grade personnel can do the job.

First Year's Budget

Only a rough estimate of the budget required for the first year can be made at this time. Yet with top market salaries to secure a staff of the right caliber, an office to equip, travel expenses, and expensive confirmatory tests of products to be made, a budget somewhat exceeding $100,000 would seem to be necessary.

In order to implement the foregoing recommendations, drafts for three working documents have been prepared and accompany this report, namely:

By-Laws;
Procedure for the Development and Revision of Standards;
Rules for the Acceptance of Products.

BY-LAWS

Article 1. Name

Section 11. The name of this organization shall be The American Surgical Materials Association (ASMA), hereinafter called the Association.

Article 2. Objects

The Association shall operate as a non-profit, scientific, and educational organization, with the following objects:

Section 21. To serve as a clearinghouse of information concerning the properties and uses of surgical materials.

Section 22. To foster research to the end of increasing knowledge of surgical materials, of improving their qualities, of making more effective use of them, and of stimulating the development of new surgical materials.

Section 23. To set up standards for surgical materials and for the performance of such materials.

Section 24. To evaluate surgical materials, and to disseminate knowledge of such evaluations to the end of bringing about more effective use of such materials.

Section 25. No part of the income or assets of the Association shall inure to the benefit of any of its members, Directors or Officers; and no substantial part of its activities shall consist of carrying on propaganda or otherwise attempting to influence legislation.

Article 3. Membership

Section 31. There shall be three classes of members, as follows:

A. *Member Bodies.* These shall be responsible, professional, technical, or trade organizations, recognized as such in their respective spheres of activity. The following shall be among the charter Member Bodies:

The American Academy of Orthopaedic Surgeons
American College of Surgeons
American Medical Association
American Hospital Association

B. *Member Companies,* which shall be companies interested in, and benefiting by, the work of the Association.

C. *Associate Members,* such as hospitals, educational and research institutions, and individuals.

Section 32. *Election of Members.* The election of all Members shall be by majority vote of the members of the Board of Directors.

Article 4. Board of Directors and Officers

Section 41. The general administrative function of the association shall be vested in a Board of Direc-

tors consisting of not less than fifteen nor more than twenty members. The Board shall include two members appointed by each of the following:

American Medical Association
American College of Surgeons
The American Academy of Orthopaedic Surgeons
American Hospital Association

The remainder of the members shall be Directors-at-Large who shall be elected by the Board. Manufacturers and fabricators shall be represented on the Board. At least two members of the Board shall have had training and experience in the field of engineering.

SECTION 42. Directors shall serve for a term of three years, approximately one third retiring each year. Initially, they shall draw lots to determine who shall serve one, two, and three-year terms. Directors may serve no more than three successive terms.

SECTION 43. *Officers.* There shall be a President and a Vice-President who shall be elected by the Board of Directors. They shall serve for a term of one year or until their successors are elected. The President and Vice-President shall not serve in these respective offices for more than four consecutive terms. The President and Vice-President shall serve as Chairman and Vice-Chairman of the Board of Directors.

SECTION 44. *A Managing Director,* who shall be the chief administrative officer of the Association, shall be appointed by the Board of Directors. He shall engage such technical and clerical staff as may be required, and he shall be responsible for their work. He shall have charge of the accounts of the Association, and shall deposit or invest its funds as instructed by the Board. He shall sign all checks, which shall be countersigned by the President or Vice-President, or by a member of the Finance Committee; except that the Board may authorize a special checking account for disbursements upon the signature of the Managing Director or acting Managing Director. He shall furnish a suitable bond, the cost of which shall be paid by the Association. The Managing Director or other designated officer shall attend all meetings of the Board. He shall record their proceedings, and may take part in their deliberations, but shall have no vote.

SECTION 45. *Meetings.* The Board shall hold at least two meetings a year.

ARTICLE 5. POWERS AND FUNCTIONS OF THE BOARD OF DIRECTORS

SECTION 51. *Acceptance of Products.* Directors who represent manufacturers, fabricators, distributors, or Government will not vote on matters having to do with the evaluation of specific products. Decisions of the Board in this matter shall be by signed ballot; and for acceptance of a product a two-thirds affirmative vote of the remaining members of the Board shall be required.

SECTION 52. *Standards.* The Board of Directors shall have supervision over standards projects, the scopes of such projects, and the personnel of technical committees dealing with standards. The adoption of standards shall be by signed ballot of the Board; and adoption shall require a two-thirds affirmative vote of the members of the Board.

SECTION 53. *Location of Central Office.* The location of the central office of the Association shall be determined by the Board of Directors, for which a three-fourths affirmative vote of its members shall be required.

ARTICLE 6. DUES

SECTION 61. The dues of all members shall be fixed by the Board of Directors.

SECTION 62. Dues of Member-Bodies and of Member-Companies shall be payable in advance for the half-year periods beginning January 1 and July 1. The initial payment of dues of Member-Bodies and Member-Companies joining after January 1 or July 1 shall be pro-rated from the date of joining.

SECTION 63. *Re-Study of Financial Structure.* During the second and third years of the operation of the Association, and from time to time thereafter, the Board of Directors shall make a thorough study of the financial structure of the organization in order to determine what changes, if any, should be made.

ARTICLE 7. ADMINISTRATIVE YEAR

SECTION 71. The administrative year of the Association shall be the calendar year.

ARTICLE 8. RULES OF ORDER

SECTION 81. Robert's Rules of Order shall govern deliberations in the Association, except as otherwise provided herein.

ARTICLE 9. AMENDMENTS

SECTION 91. These By-Laws may be amended by a three-fourths vote of the members of the Board, provided that notice of the proposed amendment shall have been mailed to all members of the Association at least thirty days in advance of the vote.

PROCEDURE FOR THE DEVELOPMENT AND APPROVAL OF STANDARDS

SECTION 1. The test of the suitability of a standard for approval is the assent of the groups having a substantial concern with the standard. Such groups have an inherent right to representation on the technical committee dealing with the subject matter of the standard; but it is not essential that this right be exercised.

SECTION 2. Standards and revisions of standards may come before the committee by any method which complies with the criterion set forth in Section 1.

SECTION 3. Proposals for standardization may be made by any group concerned, such as medical societies, manufacturers, hospitals, governmental agencies, practising surgeons, or other cooperating groups.

SECTION 4. The Board of Directors shall have supervision over standards projects, the scopes of such projects, and the personnel of technical committees dealing with standards.

SECTION 5. The personnel of each technical committee which develops or revises a standard shall be thoroughly representative of the field, so that the resulting standard may represent a consensus of those having a substantial concern with its scope and provisions. The members of the technical committee will normally speak for medical societies, manufacturers, hospitals, governmental agencies, engineers, and other interested groups—either as official representatives of organizations, or as members-at-large selected for their experience, standing, and specialized knowledge.

SECTION 6. When a technical committee has produced a draft standard which it considers near-final in form and content, it should be circulated for criticism before final action is taken. As an alternative, and with approval of the Board, the draft standard may be published for a definite period of trial and criticism.

SECTION 7. The final vote of a technical committee on a standard shall be by signed ballot, and the result, including the vote of each member, shall be reported to the Board.

SECTION 8. Formal approval of standards shall be by action of the Board of Directors, for which a two-thirds vote of the membership of the Board shall be required.

SECTION 9. An existing standard which has been developed by another agency may be approved by the Board of Directors provided either:

A. Approval is recommended by a representative technical committee after critical review of the standard; or

B. It is shown that the proposed standard is supported by a consensus of those substantially concerned with its scope and provisions (as for example, by endorsement of the groups concerned.)

SECTION 10. This procedure may be revised by the Board of Directors by a two-thirds vote of its members.

RULES FOR THE ACCEPTANCE OF PRODUCTS

Prefatory Note: The acceptance of products to be implanted in the human body requires great care because of the many disciplines involved in the technology. The following rules for guiding such work have purposely been kept simple and limited to essential principles. They can be completed and perfected only through experience in this new field.

1. BASIC REQUIREMENTS: Acceptance of a product by the American Surgical Materials Association requires evidence that the product has clinical value and that it conforms to the standards of the Association.

2. SUBMITTAL OF PRODUCT: A manufacturer when requesting approval of a product shall submit:

A. Samples of the product.

B. A list of the claims which he makes for the product on the label, in catalogs, and in advertising.

C. Samples of the label, which shall contain the accepted generic names of the materials of which the device is composed.

D. Samples of advertising and directions for use.

E. Supporting data, which shall include the results of such physical, chemical, and animal tests as are available whether made by the manufacturer or by other agencies. The results of clinical trials should be included, preferably in the form of published papers.

3. METALS: If the product submitted contains metal, the composition of the metal shall be stated, together with heat treatment and the nature and extent of the cold working to which it may have been subjected.

If the part must withstand mechanical stress, for example, as in weight-bearing, the following data shall be supplied:

Yield strength;
Tensile strength;
Elongation;

Shear strength;
Impact-test data;
Hardness;
Resistance to fatigue.

4. PLASTICS: If the product submitted contains a plastic, all essential information regarding its composition shall be submitted.

If the part must withstand mechanical stress, for example, as in weight-bearing, the following data shall be supplied:

Data for both flexure and tension:
Stress at yield,
Strain at yield,
Stress at fracture,
Strain at fracture;
Creepage;
Shear strength;
Impact-test data;
Hardness;
Resistance to fatigue.

5. COMPATIBILITY: Parts and devices of different composition used in conjunction with each other within the body must be biologically compatible.

6. TECHNICAL COMMITTEE ACTION: Each product submitted, together with supporting data, shall be referred to a technical committee for study, and for supplementary investigation and test, including tests of samples purchased on the open market. The technical committee shall embody its findings and recommendations in a report which shall be submitted to the Board of Directors for action.

7. STATISTICAL QUALITY CONTROL: The use of a system of statistical quality control by a manufacturer shall be given due weight in evaluating the product, provided the technical committee in charge be given full access to the pertinent data.

8. FORMAL ACTION: Acceptance of a product shall require an affirmative two-thirds vote of those members of the Board who are neither manufacturing representatives nor Government employees.

9. PROVISIONAL ACCEPTANCE: In special cases, the Board may make its acceptance of a product provisional, as in the case of new products. Provisionally accepted products shall be reconsidered within a period of one year.

10. PUBLICATION OF REPORT: After approval by the Board, the report may be released for publication.

11. RIGHT TO USE SEAL: Upon acceptance of a product by the Board, the product shall be placed upon the list of accepted products; and the manufacturer of the product shall have the right to use the Association's Seal of Acceptance, subject to the rules laid down by the Board.

12. CHANGES IN PRODUCT: The manufacturer of an accepted product shall immediately notify the Association of any change in the product or in his published claims for the product.

13. CONTINUING VISÉ: Each technical committee in charge of a product shall maintain a continuing visé of the product as it appears on the market, and may make such tests as it deems necessary to assure continuing conformance with the pertinent standards.

14. WITHDRAWAL OF ACCEPTANCE: The Board may, for due cause, withdraw its acceptance of any product, which withdrawal shall require a majority vote of those members of the Board who are neither manufacturing representatives nor Governmental employees.

15. THE ASSOCIATION MAY INITIATE INVESTIGATIONS: The Association may consider itself called upon, in order to fulfill its obligations to the surgical profession and to the public, to investigate and render reports upon materials and devices which have not been submitted to it if it considers such action important to the public health and welfare.

16. AMENDMENTS: These Rules may be amended by a two-thirds vote of the Members of the Board of Directors.

Representing the American College of Surgeons
Edwin F. Cave, M.D.
Frank H. Mayfield, M.D.
Harrison L. McLaughlin, M.D.
Representing the American Medical Association
John Grandlay, M.D.
Mims Gage, M.D.
Ralph DeForest, M.D.
Representing The American Academy of Orthopaedic Surgeons
Leonard Peterson, M.D.
Hugh Smith, M.D.
Joseph S. Barr, M.D., *Chairman*

Proceedings

HOSPITAL FOR JOINT DISEASES

The Sixth Annual Alumni Conference of the Hospital for Joint Diseases was held at the Hospital, in New York City, October 29 to 31, 1953, under the presidency of Dr. Raphael R. Goldenberg. The participating guests were: Dr. Sten Friberg, Professor of Orthopaedic Surgery, Karolinska Institute, Stockholm, Sweden; Dr. Ernest Gardner, Professor of Anatomy, Wayne University College of Medicine, Detroit, Michigan; Dr. Arthur Steindler, Emeritus Professor of Orthopaedic Surgery, State University of Iowa Medical School, Iowa City, Iowa; Dr. Gerald H. Pratt, Associate Clinical Professor of Surgery, New York University Medical School, New York City; and Dr. Henry H. Kessler, Kessler Institute, West Orange, New Jersey.

The opening session on Thursday morning, October 29, was devoted to a Clinic on Low-Back Pain under the chairmanship of Dr. Joseph E. Milgram. A series of problem cases was presented by the Resident Staff. Prof. Friberg, the moderator, analyzed each of the cases. He emphasized the importance of bony alterations present at the site of disc protrusions as a factor responsible for the persistence of symptoms. He also discussed nerve-root damage which may remain as a cause of symptoms after surgery.

Prof. Friberg then delivered the Walter M. Brickner Lecture, his subject being "Lumbar-Disc Degeneration in Relation to Low-Back Pain", which he termed the "lumbago-sciatica syndrome". He reviewed his Clinic's previously published anatomical and experimental studies on disc degeneration. He believed abnormal anteroposterior vertebral-body mobility as demonstrated by roentgenograms made with the patient in forward and backward bending in the erect position to be an early sign of degeneration. He correlated his clinical study with anatomical studies of 100 fresh cadavera in which the sacrum had been fixed in a vise and the trunk had been flexed. Roentgenograms were made, and the discs were subsequently examined. Detailed findings were presented which indicated the reliability of instability as seen roentgenographically as evidence of disc degeneration. Why the straight-leg-raising test may be negative in the horizontal position but positive in a standing position was explained as being due to changed loading on the disc or altered intradiscal pressure. The frequency and the role of disc degeneration in low-back pain had been studied in 15,000 cases from 1936 to 1946. In recent years it had been ascertained that disc degeneration was present in about 50 per cent. of the cases of low-back pain. The majority of patients with chronic lumbago showed disc degeneration.

Studies had been made of the economic status of patients with low-back pain; these revealed that disc degeneration occurred as frequently in patients with sedentary occupations as in those employed in hard labor.

Visualization of the disc by clinical discography had been stimulated by the findings that, when discs in cadavera were injected, some discs which had been normal as seen by roentgenogram would show on injection a large cavity extending from the anterior to the posterior margins of the disc.

Prof. Friberg reported preliminary results of a coordinated effort to discover the ultrastructure and mechanism of diffusion and nutrition of normal and pathological cartilage. So far, it appears that the nucleus pulposus consists of a very fine network of collagen fibrils tightly covered with a mucoid membrane of chondroitin-sulphuric acid. The mucoid membrane of chondroitin-sulphuric acid decreases and even disappears with advancing age. Only molecules of less than a certain size can diffuse through the cartilage.

He outlined the histological, biochemical, and mechanical functional studies in progress.

He related the results of necessarily non-etiological therapy and emphasized the place of conservative treatment in his Clinic's program. He has increasingly been using thoracopelvic traction in bed. He commented on the problems of job placement and mental conflicts in connection with proposed surgery.

Reviewing his experience for a period of ten years, 1939 to 1948, with 20,000 cases, he emphasized the value of absorbable abrodil myelography (3,000 cases) in helping to outline indications. In this group, only 126 fusions were performed. His results may be summarized as follows: A follow-up investigation made two years ago of the results in patients treated with fusion as compared with the results in those treated conservatively showed that after conservative treatment 39 per cent. of the patients showed good results, 16 per cent. of the patients were improved, and nearly 83 per cent. of the patients were able to work. After fusion, good results were obtained in 65 per cent.; 16 per cent. were improved. Of the 919 patients subjected to disc surgery who have been observed for five years, the results were excellent in 60 per cent. and good in 24 per cent. Nonetheless, he stressed that only if the conservative treatment does not lead to a satisfactory result is an operation indicated. He reserves fusion for those patients who after excision of the disc still complain of persistent severe low-back pain.

The afternoon session on Thursday, October 29, was devoted to a Symposium on Skeletomuscular Tumors, held under the chairmanship of Dr. Charles J. Sutro with Dr. Henry L. Jaffe acting as moderator.

A case of fibrosarcoma of the scapula was presented by DR. MURRAY BURTON.[1] It was pointed out that the tissue pattern of the fibrosarcoma in this case was that of a well differentiated, collagenizing tumor. This type of fibrosarcoma is to be distinguished from an anaplastic fibrosarcoma of bone, since, unlike the latter, it does not tend to metastasize; hence there is a much better prognosis.

A case of osteogenic sarcoma of the tibia with pulmonary metastasis which had been followed for eight years was presented by DR. RAPHAEL R. GOLDENBERG.[2] In this apparently unique case, a solitary focus of metastasis appeared in a lung three years after the affected limb had been amputated. The metastatic focus was excised by lobectomy. The patient, who is apparently in good health five years after the lobectomy and eight years after the amputation, was presented.

A case of pulmonary osteo-arthropathy which developed in connection with metastasis from an osteogenic sarcoma was presented by DR. GOLDEN SELIN.[3] In this case, the patient had clubbing of the fingers and wide-spread periosteal new-bone deposition in the extremities. It was pointed out that occasionally the factor which irritates the periosteum to new-bone deposition may likewise irritate the synovial membranes of the joints and lead to polyarticular effusions.

A case of osteogenic sarcoma of the soft parts of the thigh was presented by DR. SYDNEY SEWALL.[4] Stress was laid on the importance of biopsy when "doubtful" calcifications are enountered in soft parts and on appropriate wide local resection of the tumor in its bed of surrounding tissues.

In the presentation of a case of chondrosarcoma of the soft parts of the thigh, DR. BARNARD KLEIGER[5] and DR. ANDREW SCHILDHAUS[6] emphasized the idea that cartilage tumors of the soft parts often run a long, slow course before assuming full malignancy. In the case in question, the patient had suffered four local recurrences at ever shorter intervals,—eight years, four years, one year, and finally eight months. Progressively, the recurrences have shown increased cellularity and cell atypism; and, in its last recurrence, the lesion was clearly a chondrosarcoma.

A case of synovial sarcoma (synovioma) of the shoulder region, in which there was a five-year follow-up, was presented by DR. AARON GOLD.[7] In this case, the patient had had a recurrence one year after the lesion had first been resected. Resection of the recurrent tumor was resorted to because the patient had refused a forequarter amputation. Postoperatively, 7,000 r of radiation was given, and the patient is well, without any evidence of local recurrence or of metastases.

In the presentation of a case of giant-cell tumor of the femur with metastasis to the lung prior to intervention, DR. ELIOT M. FRIEDMAN[8] brought out the relatively unfamiliar fact that a giant-cell tumor may metastasize, even though its histological tissue pattern is that of a conventional giant-cell tumor. The unique feature of the case is that, in this patient, the pulmonary metastasis was already present before the femoral lesion was subjected to curettage. Since the pulmonary metastasis was enlarging, it was resected; the histological tissue pattern was found to be exactly that of the tumor in the femur.

A problem case of a lesion in the fifth cervical vertebra, thought possibly to represent a giant-cell reparative granuloma, was presented by DR. JULIUS S. NEVIASER[9] and DR. SANFORD EISENBERG[10]; a case of benign chondroblastoma of the talus was demonstrated by DR. AARON I. SIMON[11] and DR. FELIX HEIMBERG[12]; and a case of aneurysmal bone cyst of the seventh thoracic vertebra was presented by DR. JOSEPH ALPER.[13]

The session ended with the presentation of a case of sarcoma following irradiation of a giant-cell tumor of the humerus by DR. WILLIAM G. CAHAN.[14] In this patient, an osteogenic sarcoma supervened thirteen years after the giant-cell tumor had been irradiated. The general problem of malignancy supervening at sites of irradiation of benign bone lesions was discussed. The moderator, Dr. Jaffe[15], showed a case of a giant-cell tumor in the upper end of a tibia in which, twenty-three years after irradiation of the giant-cell tumor, a malignant tumor developed at its site. This malignant tumor had a complex mesodermal pattern in which giant-cell tumor, fibrosarcoma, and osteogenic sarcoma were all amply represented.

The Friday morning session was presided over by Dr. Leo Mayer; in his opening remarks, Dr. Mayer stressed the great advances in orthopaedic surgery made by Dr. Arthur Steindler.

[1] 600 West End Avenue, New York 24, N. Y.
[2] 588 East 27th Street, Paterson 4, New Jersey.
[3] Hospital for Joint Diseases, 1919 Madison Avenue, New York 35, N. Y.
[4] 64 Garden Street, Hartford 5, Connecticut.
[5] 1150 Fifth Avenue, New York 28, N. Y.
[6] Veterans Administration Hospital, Cropsey and 7th, Brooklyn, New York.
[7] 2743 Arlington Avenue, Bronx 63, New York.
[8] 258 Genesee Street, Utica 2, New York.
[9] 1918 K Street, N.W., Washington 6, D. C.
[10] 6512 Western Avenue, Chevy Chase, Maryland.
[11] 150 Prichard Street, Fitchburg, Massachusetts.
[12] 154 Prichard Street, Fitchburg, Massachusetts.
[13] 1777 Grand Concourse, Bronx 53, New York.
[14] 444 East 68th Street, New York 21, N. Y.
[15] Hospital for Joint Diseases, 1919 Madison Avenue, New York 35, N. Y.

Reconstruction of the Paralytic Upper Extremity. Dr. Arthur Steindler discussed the various indications for fusion and transplantation in relation to the shoulder, elbow, wrist, and hand. The need for preoperative kinesiological study was urged. Emphasis was placed on the newer aspects of long-range tendon transplantation, particularly at the shoulder and elbow. In the hand, reconstruction of the thumb was discussed at length, and his experience with procedures designed to restore opposition was presented.

Transfer of Biceps and Triceps Action to Flail Fingers. Dr. Joseph E. Milgram [16] presented experimental histological data to demonstrate the character of artificially produced tendon sheaths. Artificially produced tendon sheaths form in tissue in response to the subcutaneous implantation of such relatively non-irritating foreign bodies as metallic strips or plastic materials. The author demonstrated a case in which the biceps and triceps were utilized to motivate a completely paralyzed hand. These motor muscles, detached distally from their insertions, were elongated with a double-length tendon obtained from the paralyzed flexor groups. The elongated tendons were then passed through twelve-inch long gliding channels created by the implantation of polished metal strips into the site of transplant three weeks prior to the transplantation itself. The tendon grafts were sutured distally into the grouped distal flexor tendons or similarly grouped extensor tendons in two separate operative procedures. The flexor-tendon transplantation to the biceps was the first to be completed. The triceps, shifted laterally from its insertion, empowered the extensor reconstruction. The result was active power and an active range of flexion and extension of the fingers and thumb. Specimens of the functioning artificial sheaths which were removed nine months after operation were barely distinguishable histologically from a normal sheath.

Analysis of Limitation of Knee Motion Following Femoral Lengthening. Dr. Herbert Sandick [17] presented a report of a case in which femoral lengthening was performed with a gain of two inches. The patient had a residual limitation of flexion at the knee to about 90 degrees. The possible mechanism causing this restriction of motion of the knee was discussed.

Disabling Incomplete Unrecognized Rupture of the Patellar Tendon. Dr. Isadore Zadek [18] reported the findings in three patients with disabling, incomplete, and unrecognized rupture of the patellar tendon. Such a clinical picture has not been specifically reported in the literature. Each patient had a history of two or more accidents to the knee with resultant rupture of the posterior fibers of the patellar tendon. A clinical picture of an intact patellar tendon with associated deficiencies in quadriceps function was noted by palpation. At operation, an elongated attenuated patellar tendon was found; this was shortened and improvement in function of the extensor apparatus resulted.

Anatomy of the Iliotibial Tract. Dr. Wallace Green[19] discussed the anatomy of the iliotibial tract and stressed the point that it is not an isolated anatomical structure but a portion of the deep fascia of the thigh. He maintained that, in the region of the hip, the deep fascia of the thigh is confluent with the sheath of the rectus femoris and the capsule of the hip joint. At the knee, the deep fascia, is an all-enveloping membrane inserting into the patella, as well as into the tibial crest and the head of the fibula. In the thigh itself, the deep fascia is rigidly bound down by the intermuscular septa. For these reasons, in flexion, abduction, and external rotation deformities of the hip and knee, surgical procedures directed solely to the iliotibial tract are frequently unsuccessful.

Anatomical Problem of Opposition of the Thumb. Dr. Emanuel B. Kaplan[20] presented a study of the comparative anatomy of the opposition of the thumb. Special emphasis was placed on the interpretation of opposition of the thumb in man, as well as the surgical application of opposition.

Steindler Flexoplasty. Dr. Leo Mayer[21] presented a motion-picture film illustrating the technique of the Steindler flexoplasty in the elbow. Follow-up studies were included in the film.

The Friday afternoon session was presided over by Dr. Emanuel B. Kaplan. He introduced the guest speaker, Dr. Ernest Gardner.

Physiology of Blood and Nerve Supply of Joints. Dr. Ernest Gardner stated that articular blood vessels develop during the embryonic period and shortly thereafter give off epiphyseal branches. Capillary networks are formed in capsular and synovial tissue; blood flow through them may be altered by arteriovenous anastomoses, which are common in adult joints. Nerves to joints arise from several spinal nerves and reach joints by way of the major peripheral nerves and their muscular and cutaneous branches. They vary in the manner in which they reach joints, but their intra-articular distribution is fairly constant.

[16] Hospital for Joint Diseases, 1919 Madison Avenue, New York 35, N. Y.
[17] 35 Dorchester Avenue, Pittsfield, Massachusetts.
[18] 1095 Park Avenue, New York 28, N. Y.
[19] 117 North Chatsworth, Larchmont, New York.
[20] 1001 Grand Concourse, Bronx 52, New York.
[21] 1150 Fifth Avenue, New York 28, N. Y.

Proximal joints, such as the hip and shoulder, receive fibers directly from sympathetic ganglia or trunks by way of vessel adventitia. Each major region of a joint is supplied by more than one nerve. Joint nerves contain proprioceptive, pain, vasomotor, and vasosensory fibers. Proprioceptive fibers are concerned in position sense and the reflex control of locomotion. Pain arises mainly in the capsule and is poorly localized as compared with pain in the skin. Pain may be referred and often leads to profound visceral and muscular reflexes. There is little direct information about vasomotor and vasosensory fibers in joints, except that some of the latter are pain fibers.

Pitfalls in the Diagnosis of Lower-Extremity Pain of Spinal Origin. Dr. Frederick Serbin[22] discussed the question of etiology of referred pain to the abdomen and to the lower extremity. Fragmentary sciatica, a term used to denote the appearance of referred pain in the lower extremities in isolated areas, was discussed along with its etiological relationship to degenerative disc disease, arthritis, and scoliosis.

Posterior Rhizotomy for Relief of Spasm. Dr. Harold Somberg[23] reviewed the work of Foerster and Yovcik. Posterior rhizotomies were done for relief of spasm in the lower extremities in selected cases in which some voluntary motion was still present. Preliminary results warrant further investigation. The particulars emphasized included alternate section of the nerve roots without significant sensory loss and early physical therapy.

Classification of Reflex Sympathetic Dystrophy in Relation to Treatment. Dr. Daniel Casten [24] presented a thorough surgical and physiological study of reflex sympathetic dystrophy with multiple illustrative case histories. He classified reflex sympathetic dystrophy into several groups based on clinical manifestations and response to therapy. The work was done in cooperation with the Director of Anaesthesiology, Dr. Albert M. Betcher.

What is Flat-Foot? Dr. Paul Lapidus [25] stated that very little is known about the etiology of so-called flat-foot. Comparative anatomy, evolution, and ontogenetic development of the foot, together with the analysis of clinical material, has shown a striking similarity of many features of flat-foot to those appearing in the lower primates and in the human embryo. Therefore, flat-foot should be looked upon as an arrest of the ontogenetic development in early stages of gestation, somewhat similar to that in cleft-palate or hare-lip. Therefore, the widely used treatment of flat-foot by exercises is futile. The frequently advocated operative reconstruction of a flat foot should be undertaken only reluctantly and with a great deal of preliminary study of each individual case. It has been the author's observation that flat feet which have not been operated upon have shown much better functional results than those which have been subjected to rather numerous surgical procedures.

Rotatory Dislocation of the Knee Joint. Dr. Joseph Deitz [26] reported a case of bilateral external rotation of both legs occurring within the knee joints in a newly born infant. The infant's toes pointed directly backward. This indicated rotation of approximately 180 degrees. There was, in addition, restriction of extension of the legs to 140 degrees.

The patient was treated by derotation plaster-of-Paris bandages and subsequently by reverse Denis Browne splints. Clinical correction was obtained.

On Saturday, October 31, a Symposium on Peripheral Vascular Disease was held under the chairmanship of Dr. Robert L. Nach.

Dr. Isidore Mufson [27], in discussing the diagnosis and medical management of peripheral vascular disease, stressed intra-arterial infusions of dilute solution of histamine as the basic form of therapy. Histamine causes the collateral blood vessels to dilate permanently.

Dr. Gerald H. Pratt presented a paper entitled "Indirect and Direct Surgery on the Occluded Artery". He discussed the advantages of embolectomy, arteriectomy, and venous grafting in the treatment of arterial blocks.

Dr. Arthur S. Abramson [28] discussed the value of exercises in peripheral-arterial disease. Using radio-active sodium clearance as a measure of blood flow, he found that passive exercises, such as the Buerger-Brown exercises, have no effect on peripheral-blood flow. When muscles are contracted by pressure against an immobile surface, flow is increased.

Dr. Henry H. Kessler emphasized the problems encountered in fitting prostheses to stumps with poor arterial blood supply.

[22] 99 Pratt Street, Hartford, Connecticut.
[23] 89 Lincoln Park, Newark 5, New Jersey.
[24] 71 Washington Square South, New York 12, N. Y.
[25] 1133 Park Avenue, New York 28, N. Y.
[26] 915 West State Street, Trenton 8, New Jersey.
[27] 1882 Grand Concourse, Bronx 57, New York.
[28] Veterans Administration Hospital, New York 63, N. Y.

SOUTHERN MEDICAL ASSOCIATION
SECTION ON ORTHOPAEDIC AND TRAUMATIC SURGERY

The Section on Orthopaedic and Traumatic Surgery of the Southern Medical Association met in Atlanta, Georgia, October 27 to 29, 1953, with Dr. W. Kelly West presiding. In addition to the presentation of formal scientific papers, there was presented, on October 28, by the orthopaedic surgeons of Atlanta, a clinical program over which Dr. J. Hiram Kite presided and which was of great interest. Summaries of the papers presented during the Scientific Sessions follow:

Synovectomy in Treatment of Tuberculosis of the Knee in Children. Dr. R. D. Butterworth [1] reported six cases of proved tuberculous arthritis of the knee. In his patients synovectomy had been carried out in conjunction with streptomycin therapy. The results were encouraging, and it was felt that the disease was definitely controlled and that a functional joint was preserved.

Dr. J. Hiram Kite [2], in discussion, expressed the opinion that the treatment of tuberculous arthritis, at least in children, had progressed to the point where preservation of function, even in weight-bearing joints, could be expected in a considerable proportion of cases. He felt that surgery in children is generally not necessary, treatment by streptomycin and rest of the affected part being adequate.

Surgical Treatment of Osseous Tuberculosis by Drainage and Streptomycin Therapy. Dr. George B. Higley [3], Dr. R. Beverly Ray [4], Dr. W. L. Minear [5], and Dr. R. E. Addison [6], presented the results in fifteen patients with osseous tuberculosis who were treated by débridement of the tuberculous lesions and surgical drainage, supplemented by streptomycin therapy. Favorable results were obtained with apparent arrest of the disease, without ankylosis.

Non-Rachitic Bowing of the Tibia. Dr. Robert Stempfel [7] and Dr. Amos Christie [8] showed lantern slides of a small series of cases exhibiting a moderate degree of bowing of the tibia, non-rachitic in origin, in which spontaneous correction with growth occurred. No supportive orthopaedic measures were employed.

The inference that this is a universal occurrence was sharply challenged by Dr. Kite, who did concede, however, that the average case of moderate severity would probably undergo spontaneous correction.

Congenital Pseudarthrosis of the Tibia. Dr. Antonio Berrios [9], Dr. Frank H. Stelling [10], and Dr. Leslie C. Meyer [11] presented a large series of cases of congenital pseudarthrosis of the tibia. Two methods of treatment were used: (1) dual onlay grafts with added cancellous bone and (2) telescoping osteotomy. They felt that the telescoping osteotomy is an excellent procedure in selected cases, resulting in a higher proportion of union than other methods.

Congenital Anterior Dislocation of the Knee. Dr. Richard T. Odell [12], and Dr. Earl F. Holt [13] presented six cases of congenital anterior dislocation of the knee. Excellent slides were shown of the dissection in one case of congenital anterior dislocation, which revealed the pathological basis of the lesion. Good results from treatment were shown to follow early conservative management, although in the late cases surgery was occasionally necessary. The results in these cases were less satisfactory.

In discussion, Dr. Jack K. Wickstrom [14] reported that in some cases there was spontaneous recovery without treatment.

Clinical Experiences with Epiphyseal Stapling. Dr. James B. Dalton, Jr.[15], and Dr. Earnest B. Carpenter [16] showed that by careful attention to detail and by the use of staples which were adequate in size

[1] Professional Building, Richmond, Virginia.
[2] 490 Peachtree Street, N.E., Atlanta, Georgia.
[3] 954 Madison Avenue, Memphis 3, Tennessee.
[4] 954 Madison Avenue, Memphis 3, Tennessee.
[5] Carrie Tingley Hospital for Crippled Children, Truth or Consequences, New Mexico.
[6] 954 Madison Avenue, Memphis Tennessee.
[7] Vanderbilt University Hospital, Nashville, Tennessee.
[8] Vanderbilt University Hospital, Nashville, Tennessee.
[9] 206 East North Street, Greenville, South Carolina.
[10] 206 East North Street, Greenville, South Carolina.
[11] 206 East North Street, Greenville, South Carolina.
[12] Washington University School of Medicine, St. Louis, Missouri.
[13] Washington University School of Medicine, St. Louis, Missouri.
[14] 1430 Tulane Avenue, New Orleans, Louisiana.
[15] Medical College of Virginia, Richmond, Virginia.
[16] 401 Medical Arts Building, Richmond, Virginia.

and number, epiphyseal arrest could be well controlled. The pitfalls of this method of treatment were pointed out, as well as the advantages to be expected. It was not recommended for young children, and it was felt that the staples should not be left in place for more than two years if any resumption of growth was to be expected.

Traumatic Paraplegia: A Classification and Fifteen-Year Follow-up. Dr. Ralph W. Coonrad [17] and Dr. Edward S. Whitesides [18] had found in the study of a large number of cases of traumatic paraplegia that the prospect of a reasonable degree of rehabilitation is good if the paraplegia is incomplete or if it is below the level of the tenth thoracic vertebra. In the presence of complete lesions above this level, the rehabilitation of the patient, as far as any ambulation is concerned, seems hopeless, regardless of the effort spent. It was interesting to note that, in this group of cases, complete paraplegia occurred predominantly in those persons who had been in automobile accidents and who were not thrown out of the car. Paraplegia resulting from a fall or from an automobile accident in which the person was thrown out of the car was usually incomplete.

Orthopaedic Aspects of Leprosy. Dr. Daniel C. Riordan [19] and Dr. Rufus H. Alldredge [20] discussed the various lesions of the extremities produced by leprosy. Very striking improvement was shown to follow proper tendon transfers when loss of intrinsic-muscle function existed in the hand. Occasionally tendon transfers were indicated in the lower extremities to restore muscle balance. Proper bracing and corrective shoes were often indicated, and amputation was occasionally necessary.

Management of Transcervical and Subcapital Fractures of the Femur. As guest speaker of the organization, Dr. James A. Dickson [21] clearly outlined the problems inherent in the management of intracapsular fractures of the neck of the femur. He emphasized the need for anatomical reduction and felt that the Jewett-type nail was preferable to the Smith-Petersen nail because it gave better internal fixation. In patients in whom non-union is impending, he showed that cancellous bone-grafting would often promote union and would bring about an excellent result. In connection with bone-grafting, it was sometimes necessary, when the fracture line was vertical, to do an osteotomy to reduce the shearing stress. By early and vigorous attack on the complications which appeared in these hips, many could be salvaged with an excellent chance for success without the necessity for more radical procedures.

Priorities and Life-Saving Measures in Multiple Injuries. Dr. Oscar P. Hampton [22] outlined the immediate causes of death in severely injured patients and discussed the measures by which many of these deaths could be averted. This was a basic and scholarly presentation, deserving careful study by all surgeons called upon to treat traumatic injuries. The orthopaedic surgeon must recognize life-endangering pathological conditions, including damage to the vital centers of the brain, even though bones are not involved; and he must be prepared to institute appropriate corrective measures promptly to assure adequate oxygenization and circulating blood volume.

Hip Prosthesis. As a result of his study of sixty-eight patients subjected to the insertion of a hip prosthesis, Dr. Leonard T. Peterson [23] discussed the type of case deserving this method of treatment, as well as the technique, type of prosthesis, and postoperative care which he has found to be most successful. The complications encountered and the results of treatment were carefully analyzed.

Arthrodesis of the Wrist. Dr. Jack K. Wickstrom [24] presented a series of twenty-six cases of arthrodesis of the wrist in which fusion was obtained in 95.4 per cent. by the use of a split homogenous rib graft, according to the technique described by Colonna. Technique, postoperative care, and selection of patients were discussed, as well as the position of fusion.

Chondromyxoid Fibroma. Dr. Richard N. Wrenn [24] and Dr. Albert C. Smith [25] reported five additional cases of the rare, rather confusing lesion, chondromyxoid fibroma, which, although benign, has probably been mistaken in the past for chondrosarcoma. The awareness of the existence of the lesion and its histological characteristics, along with roentgenographic and clinical data, should allow the diagnosis to be accurately established.

[17] Duke University Hospital, Durham, North Carolina.
[18] Georgia Warm Springs Foundation, Warm Springs, Georgia.
[19] 1538 Louisiana Avenue, New Orleans, Louisiana.
[20] 1538 Louisiana Avenue, New Orleans, Louisiana.
[21] 2020 East 93rd Street, Cleveland, Ohio.
[22] Beaumont Medical Building, 3720 Washington Boulevard, St. Louis 8, Missouri.
[23] 915 19th Street, Washington, D. C.
[24] Georgia Warm Springs Foundation, Warm Springs, Georgia.
[25] Duke University, Durham, North Carolina.

Benign Lesions Often Mistaken for Bone Sarcoma. Dr. Mary S. Sherman [26] discussed several bone lesions which are often mistaken for malignant tumors, including epiphyseal chondroblastoma, traumatic myositis ossificans, eosinophilic granuloma, fibrous dysplasia, chondromyxoid fibroma, and non-ossifying fibroma. A plea was made for the utilization of all methods of diagnosis, including roentgenographic study, clinical data, and gross examination of the specimen.

In the discussion of the two preceding papers by Dr. Everett Bishop [27] and Dr. Samuel B. Prevo [28], it was emphasized that in many instances in which surgery had been credited with the cure of sarcomata, the diagnosis was in error; the patient could have been cured with less radical surgery.

Repair of Benign Bone Tumors. Dr. W. Kelly West [29], in his Chairman's Address, discussed the local resection of benign tumors and repair by autogenous cortical grafts following resection. Autogenous cortical grafts were preferred because they give increased stability which is often badly needed when joint surfaces are approached, and further, because they allow the restoration of the normal contour, particularly in such superficial bones as the lower portion of the tibia.

The Use of Hydrocortisone (Compound F) in Orthopaedic Surgery. Dr. Fred C. Reynolds [30] and Dr. R. H. Ramsey [31] presented their experience in the use of hydrocortisone in more than 500 patients with various joint and tendon disorders. For the most part, it was used as an office procedure with a minimum of complications. Results obtained by treatment were carefully analyzed, and the value of the drug in properly selected cases was evident.

Surgical Treatment of Fractures of the Patella. Dr. A. H. Crenshaw [32] and Dr. Frank D. Wilson [33], in an analysis of a large series of cases of fractures of the patella, made several points strikingly evident. The procedures commonly used were patellectomy, partial excision of the patella with repair of the quadriceps mechanism, and open reduction with circumferential wiring of the patella. In the analysis of the end results, there was no great difference to be noted from the various methods of treatment. Practically all patients retained some disability, and the convalescence was protracted. The seriousness of this fracture as regards the duration of disability and the extent of permanent disability is probably generally underestimated by orthopaedic surgeons.

The Use of Patellectomy. Dr. Ira H. Rapp [34] reviewed a large number of patellectomies done over a period of six years and analyzed the indications for patellectomy, the surgical technique, and the postoperative care. Mobility of the knee following patellectomy was found to be relatively normal; however, by use of the dynamometer, it was definitely shown that there is a loss of power in extension of the knee which is greatest as full extension is approached.

At the business meeting which followed, Dr. R. Beverly Raney was elected Chairman of the Section. Dr. G. W. N. Eggers was elected Vice-Chairman, and Dr. S. Benjamin Fowler was reelected Secretary. The 1954 meeting will be held in St. Louis, Missouri, November 8 to 11.

[26] Ochsner Clinic, Prytania and Aline Streets, New Orleans 15, Louisiana.
[27] Atlanta, Georgia.
[28] 2108 West End Avenue, Nashville 5, Tennessee.
[29] 1200 North Walker Street, Oklahoma City, Oklahoma.
[30] 300 Medical Arts Building, 4952 Maryland Avenue, St. Louis 8, Missouri.
[31] 300 Medical Arts Building, 4952 Maryland Avenue, St. Louis 8, Missouri.
[32] Campbell Clinic, 869 Madison Avenue, Memphis, Tennessee.
[33] Campbell Clinic, 869 Madison Avenue, Memphis, Tennessee.
[34] Miller Orthopaedic Clinic, Medical Arts Building, Charlotte, North Carolina.

RICHARD B. DILLEHUNT
1886–1953

Almost everybody who came in contact with Dr. Richard B. Dillehunt recognized the genius of his professional leadership and the warmth of his humanity; everybody, sooner or later, wished to be his friend. Perhaps his greatest achievement, however, lies in the fact that even the most professional eulogy of "Dilly" is apt to begin with a comment on his Lincolnesque wit and humor, and to include always a mention of his sympathy and gentleness. In 1937, a recognized leader in medical education and a distinguished orthopaedic surgeon, he became the "First Citizen" of Portland, Oregon.

In the field of medical education, Dr. Dillehunt's contribution was internationally recognized. Named Dean of the University of Oregon Medical School in 1920, his foresight and inspired leadership were responsible in great part for the Class A rating and the position of prominence the School holds today. The present Medical School, its magnificent library, the Doernbecher Children's Hospital, the Multnomah County Hospital, and the new Teaching Hospital were brought together and amalgamated by his efforts, and stand as a monument to his unusual ability to organize and inspire.

As the present Medical School owes much of its fine reputation to Dr. Dillehunt's organizing and teaching abilities, the Shriners' Hospital for Crippled Children is the result of his creativeness. Consulted frequently during the initial planning, he was named the first Surgeon-in-Chief, and was also recognized as one of the outstanding orthopaedic surgeons among the Shriners' Hospitals in the United States.

Among other titles and honors, he was Clinical Professor of Surgery at the University of Oregon Medical School, President of the Pacific Coast Surgical Association 1939–1940, and was named by President Roosevelt to be a member of the Advisory Committee of Orthopaedic Surgeons of the Georgia Warm Springs Foundation. He was a member of The American Orthopaedic Association and The American Academy of Orthopaedic Surgeons, and was a Fellow of the American College of Surgeons.

He was born July 12, 1886, in Decatur, Illinois. He took his academic degree at the University of Illinois, and his medical degree at the University of Chicago. He served in World War I, when he was Chief of the Orthopaedic Service in Base Hospital 46. In 1911, he went to Portland, Oregon, to take the Chair of Anatomy at the University of Oregon Medical School; he became Dean in 1920, and he retained this title until ill health forced him to retire from practice. He died quietly in his sleep on October 31, 1953.

Ironically, "Dilly" is remembered for his jokes and witticisms, while his scholarly publications in the field of medical research are known only to the few. His heroic struggles to further medical knowledge and to provide better facilities for learning and practising are sometimes overlooked in the light of his reputation as a brilliant conversationalist and raconteur. From his student days to his retirement, his light-hearted approach to a profession to which he was devoted became a legend.

He was a wonderful person who will be deeply missed by a great number of friends, by his community, and by his country.

News Notes

THE AMERICAN ORTHOPAEDIC ASSOCIATION

The Sixty-seventh Annual Meeting of The American Orthopaedic Association will be held at Bretton Woods, New Hampshire, June 7 to 10, 1954, under the presidency of Dr. A. R. Shands, Jr. Prof. Walter Mercer of Edinburgh will be the guest of the Association at this meeting. In addition to the Scientific Program, there will be a golf tournament and an opportunity for those attending to show their hobby movies.

The following program has been arranged:

MONDAY, JUNE 7

Morning Session

9:00 A.M.

Idiopathic Scoliosis: Experimental and Metabolic Studies.
I. V. Ponseti, M.D., Iowa City, Iowa (by invitation);
Genevieve Stearns, Ph.D., Iowa City, Iowa (by invitation).

Avascular Necrosis Involving Articular Surfaces.
W. E. Gallie, M.D., Toronto, Ontario, Canada.

Arthrodesis of the Hip by Wide Abduction in Massive Destruction of the Joint.
LeRoy C. Abbott, M.D., San Francisco, California;
Donald D. Lucas, M.D., San Francisco, California (by invitation).

An Analysis of Results to be Expected in Surgical Treatment of Ligament Injuries to the Knee.
Don H. O'Donoghue, M.D., Oklahoma City, Oklahoma.

11:15 A.M.

Presidential Address.
A. R. Shands, Jr., M.D., Wilmington, Delaware.

11:45 A.M.

First Executive Session.

TUESDAY, JUNE 8

Morning Session

Effect of Feeding Trace Minerals to Rats.
J. Albert Key, M.D., St. Louis, Missouri;
Richard T. Odell, M.D., St. Louis, Missouri (by invitation).

The Use of Radio-Active Phosphorus (P^{32}) in Predicting the Viability of the Femoral Head Following Fractures of the Neck.
Harold B. Boyd, M.D., Memphis, Tennessee;
D. B. Zilversmit, Ph.D., Memphis, Tennessee (by invitation);
R. A. Calandruccio, M.D., Memphis, Tennessee (by invitation).

Comparison of the Beneficial Effects of ACTH and Cortisone and the Deleterious Effects of Immobilization in Paget's Disease.
Philip H. Henneman, M.D., Boston, Massachusetts (by invitation);
Frederick C. Bartter, M.D., Boston, Massachusetts (by invitation);
Eleanor F. Dempsey, M.A., Boston, Massachusetts (by invitation);
Evelyn L. Carroll, A.B., Boston, Massachusetts (by invitation);
Fuller Albright, M.D., Boston, Massachusetts (by invitation).

Bone and Joint Tuberculosis.
Walter Mercer, F.R.C.S., Edinburgh, Scotland.

Treatment of Bone and Joint Tuberculosis.
David M. Bosworth, M.D., New York, N. Y.;
J. William Fielding, M.D., New York, N. Y. (by invitation);
Hudson Wilson, M.D., New York, N. Y. (by invitation);
Manuel Guzman Acosta, M.D., New York, N. Y. (by invitation);
L. M. Demarest, M.D., New York, N. Y. (by invitation).

A Simplified Wrist Arthrodesis.
J. Warren White, M.D., Honolulu, Hawaii;
Richard D. Smith, M.D., Honolulu, Hawaii (by invitation).

Afternoon Session

Symposium on Crippled Children's Services.

1. Point of View of the Federal Administrator.
   Martha Eliot, M.D., Chief of the Children's Bureau, Department of Health, Education, and Welfare, Washington, D. C.
2. Point of View of the State Administrator.
   H. R. Kobes, M.D., Director of Crippled Children's Services, State of Illinois, Springfield, Illinois.
3. Point of View of the Orthopaedic Surgeon.
   William T. Green, M.D., Boston, Massachusetts.
4. Foreign Services.
   Services in Scotland.
   Walter Mercer, F.R.C.S., Edinburgh, Scotland.
   Services in England.
   S. Alan S. Malkin, F.R.C.S., Nottingham, England.
   Services in Greece.
   T. Garofalides, M.D., Athens, Greece.

WEDNESDAY, JUNE 9

Morning Session

Prognostic Implications of Electromyography in Acute Poliomyelitis.
Fritz Buchtal, M.D., Copenhagen, Denmark (by invitation);
Helge Hertz, M.D., Copenhagen, Denmark (by invitation);
Anneliese Madsen, M.D., Copenhagen, Denmark (by invitation).

Patterns of Innervation and Muscle Contraction.
Joseph E. Markee, Ph.D., Durham, North Carolina.

Electron Microscopic Studies of Muscle.
David Spiro, M.D., Boston, Massachusetts (by invitation).

The Present Status of the Research Program in Poliomyelitis.
Hart E. Van Riper, M.D., New York, N. Y. (by invitation).

Fixed Pelvic Obliquity.
George J. Garceau, M.D., Indianapolis, Indiana.

Clinical Evaluation of Freeze-Dried Bone Grafts.
Commander Chalmers R. Carr, Medical Corps, United States Navy (by invitation);
Lieutenant Commander George W. Hyatt, Medical Corps, United States Navy (by invitation).

Evening

President's Cocktail Party and Dinner Dance.

THURSDAY, JUNE 10

Morning Session

The Significance of Lumbodorsal Changes in Low-Back Pain.
Ian Macnab, M.B., Toronto, Ontario, Canada (by invitation).

The Study of Ground Substance in Intervertebral-Disc Degeneration.
Barnes Woodhall, M.D., Durham, North Carolina (by invitation).

Personal Experiences in the Evolution of Orthopaedic Surgery.
Leo Mayer, M.D., New York, N. Y.

Plastic Flat-Foot Operation. Thirty-Year Follow-up Study.
Oscar Lee Miller, M.D., Charlotte, North Carolina.

Arthrodesis of the Subastragalar with Bone Grafts.
David S. Grice, M.D., Boston, Massachusetts (by invitation).

Noon

Second Executive Session.

AMERICAN MEDICAL ASSOCIATION
SECTION ON ORTHOPAEDIC SURGERY

The American Medical Association meets this year in San Francisco from June 21 through 25.

The Section on Orthopaedic Surgery will be conducted under the chairmanship of Dr. Charles N. Pease of Chicago, Illinois.

Dr. Jesse T. Nicholson of Philadelphia is Vice-Chairman of the Section.
A very interesting program has been arranged and will include the following:

TUESDAY, JUNE 22

Afternoon Session, 2:00 P.M.

Skeletal Lesions in Coccidioidomycosis.
Robert Mazet, Jr., M.D., Los Angeles, California.
Diabetic Neuropathic Arthropathy.
Donald S. Miller, M.D., Chicago, Illinois;
William F. Lichtman, M.D., Chicago, Illinois.
The Clinical Significance of the Transitional Lumbosacral Vertebra.
Frank E. Stinchfield, M.D., New York, N. Y.;
William A. Sinton, M.D., Danbury, Connecticut.
The Use of Iproniazid in the Treatment of Non-Tuberculous Bone and Joint Infection.
David M. Bosworth, M.D., New York, N. Y.;
J. William Fielding, M.D., New York, N. Y.;
Manuel Guzman Acosta, M.D., New York, N. Y.;
L. M. Demarest, M.D., New York, N. Y.
Metastatic Lesions Simulating Rupture of a Lumbar Intervertebral Disc.
Richard T. Odell, M.D., St. Louis, Missouri;
J. Albert Key, M.D., St. Louis, Missouri.
The Prevention of Delayed Union or Non-Union in the Treatment of Fractures.
Edward L. Compere, M.D., Chicago, Illinois.

WEDNESDAY, JUNE 23

Afternoon Session, 2:00 P.M.

Election of Officers.
The Use of Internal Fixation in Compound Fractures of the Extremities.
H. Phillip Dohn, M.D., Eureka, California.
Pigeon Breast, Funnel Chest, and Other Congenital Deformities of the Anterior Chest Wall.
Charles W. Lester, M.D., New York, N. Y.
Chairman's Address.
Charles N. Pease, M.D., Chicago, Illinois.
Results of Stabilizing Spine Fusion in Cases of Previous Herniated Disc Removal without Fusion.
A. Della Pietra, M.D., Middlebury, Connecticut.
Acute Calcific Deposits in the Hand.
Robert E. Carroll, M.D., New York, N. Y.;
Alexander Garcia, M.D., New York, N. Y.

THURSDAY, JUNE 24

Afternoon Session, 2:00 P.M.

Dual Pinning in Supracondylar Fracture of the Femur.
Dana M. Street, M.D., Memphis, Tennessee;
Anibal L. Lugo, M.D., San Juan, Puerto Rico.
Prevention and Correction of Adduction Contracture of the Thumb.
J. William Littler, M.D., New York, N. Y.
Transplant of the Biceps Femoris to the Patella by the Medial Route in Poliomyelitic Quadriceps Paralysis.
Gene D. Caldwell, M.D., Shreveport, Louisiana.
Bryant's Traction. A Provocative Cause of Circulatory Complications.
Jesse T. Nicholson, M.D., Philadelphia, Pennsylvania;
Robert M. Foster, M.D., Philadelphia, Pennsylvania;
Robert D. Heath, M.D., Philadelphia, Pennsylvania.
Interbody Spinal Fusion. Preliminary Report.
John R. Stacy, M.D., Oklahoma City, Oklahoma;
Earl D. McBride, M.D., Oklahoma City, Oklahoma.
Vitallium-Mold Arthroplasty of the Hip. An End-Result Study.
George Hammond, M.D., Boston, Massachusetts;
Howard R. Crawford, M.D., Boston, Massachusetts;
G. Edmund Haggart, M.D., Boston, Massachusetts

The Annual Meeting of the **Texas Orthopaedic Association** will be held in San Antonio, May 3, 1954. The scientific program will take place in the morning; in the afternoon the group will visit the Brooke General Hospital at Fort Sam Houston. The guest speaker will be Dr. William T. Green of Boston.

The Part I examinations of **The American Board of Orthopaedic Surgery** will be held April 16 and 17, 1954, at St. Louis, Missouri, at Charlottesville, Virginia, and probably at San Francisco, California.

Doctors are urged to make arrangements as soon as possible to attend the **Sixth Pan-Pacific Surgical Congress** to be held in Honolulu, Hawaii, October 7 through October 18, 1954.

An outstanding program, including sessions in all divisions of surgery and related fields, promises to be of interest to all doctors.

The Association office has been appointed as travel agent for those attending the Congress, and it is important that all hotel and travel reservations be made through the Honolulu headquarters of the Pan-Pacific Surgical Association.

For further information, please write to F. J. Pinkerton, M.D., Director General, Pan-Pacific Surgical Association, Suite 7, Young Hotel Building, Honolulu, Hawaii.

The many friends of Dr. Arthur Steindler of Iowa City, Iowa, will be happy to learn of his election as a Fellow of the Royal College of Surgeons of England.

La Sociedad de Estudios Clínicas de la Habana announces the election of the following officers for the two-year period 1953 to 1955:

President: Dr. Frank Canosa Lorenzo
Vice-President: Dr. Julio Sanguily
Secretary: Dr. Juan Portuondo de Castro
Vice-Secretary: Dr. Manuel Villaverde
Treasurer: Dr. Luis Ortega Verdes
Vice-Treasurer: Dr. Moisés Chediak

Columbia University and the **Institute for the Crippled and Disabled** announce the inauguration of a program of training in rehabilitation designed to meet the needs of professional workers and graduate students on June 1, 1954. At that time Teachers College, Columbia University, and the Institute for the Crippled and Disabled will join in conducting a three and one-half week **Field Workshop in Rehabilitation Teamwork.**

Thirty-five professional workers, already trained and experienced in their own disciplines, will be admitted to the course. This group will be divided into closely knit, balanced rehabilitation teams which will include experienced personnel from the Staff of the Institute. These teams will function as dynamic educational units within the Field Workshop.

The co-directors of the Field Workshop in Rehabilitation Teamwork will be Dr. Maurice H. Fouracre, Chairman, Department of Special Education, Teachers College, Columbia University, and Willis C. Gorthy, Director, Institute for the Crippled and Disabled. The coordinators of the Field Workshop are William Usdane, Director of Vocational Rehabilitation, Institute for the Crippled and Disabled, and Dr. Herbert Rusalem, of the Staff of the Department of Special Education at Teachers College.

Further information and application blanks may be obtained by writing to Dr. Maurice H. Fouracre, Teachers College, Columbia University, New York 27, N. Y.

The Sixth Congress of the **Société Internationale de Chirurgie Orthopédique et de Traumatologie** will be held at Berne, Switzerland, from August 30 to September 3, 1954.

The Congress will be held under the presidency of Prof. Etienne Sorrel, with Prof. Richard Scherb as Honorary President.

All correspondence should be addressed to the Secretary-General of the *Société*, Dr. Jean Delchef, 34, Rue Montoyer, Bruxelles, Belgium, from whom enrollment form and application for room reservation may be obtained. Application should be completed and returned before May 31, 1954.

Doctors who are not members of the *Société* and the relatives of active or retired members may participate as guests. They will pay a registration fee of forty Swiss francs.

After May 31, 1954, enrollments may not be accepted, and the registration fee for guests will be increased by 50 per cent.

Those wishing to participate in the discussion of the reports should so inform the Secretary General and send him a summary of 250 words before May 31, 1954.

Any member of the *Société* wishing to present a particular paper should send to the Secretary General, through his National Committee, a summary of 250 words, bearing the statement: "I certify that this communication has not been published, either in substance or form". This must also be done before May 31, 1954. Applications to present papers made after May 31 will be decided upon by the local committee.

Each properly enrolled participant will receive a card which may be exchanged at Berne for a folder. This folder will contain a Congress badge, the program of the Congress, the text of the reports, summaries of techniques and of papers, summary of lectures to be delivered during visits outside of Berne on Wednesday, September 1, 1954, and a card of admittance to the said visits and to the social functions of the Congress.

The preliminary program of the Congress includes:

Monday, August 30, 1954

Official opening of the Congress.
First scientific meeting. The Treatment of Scoliosis.
Mr. Bryan McFarland;
Mr. I. J. F. James.
Miscellaneous matters.

Tuesday, August 31, 1954

General Assembly.

Wednesday, September 1, 1954

Visits in groups to various Swiss medical centers.
Group I.—Basel.
Visits to hospitals, with clinical demonstrations.
Symposium: Orthopaedic and Traumatologic Problems in Gerontology.
Introduction: Mr. A. S. Vischer;
Co-Reporters: Mr. Nissen and Prof. Hans Debrunner.
Group II.—Berne/Macolin (in the Bernese Jura).
Visits to hospitals, with clinical demonstrations.
Symposium: The Physiological Background of Maximal Performance in Sports.
Introduction: Mr. Howüh-Christensen (Stockholm);
Co-Reporters: Mr. A. von Muralt and Mr. Grandjean.
Visit to the Federal School for Gymnastics and Sports at Macolin.
Group III.—Geneva.
Visits to hospitals with clinical demonstrations by M. Jentzer and Dr. A. Perrot.
Statement on the Physiopathology of Fractures by M. Patry.
Symposium: Arthrosis of the Hip.
Introduction: Mr. Rutishauser;
Co-Reporters: M. Bardet and M. Perrot.
Group IV.—Lausanne-Leysin.
Clinical demonstrations by M. J. C. Scholder, M. Decker, and M. L. Nicod.
Statement on Muscle Degeneration and Its Treatment by Mr. A. Fleisch.
Visit to the Clinic Manufacture (Leysin).
Symposium: Osteo-Articular Tuberculosis.
Introduction: Prof. E. Sorrel;
Co-Reporters: M. Gerard-Marchant and M. Wasserfallen.
Group V.—Zurich.
Visits to hospitals, with clinical demonstrations.
Statement on the Legal Basis of the Medicine of Accidents in Switzerland by Mr. F. Lang.
Symposium: Physiology and Pathology of Locomotion.
Introduction: Mr. O. Wyss;
Co-Reporters: Prof. M. R. Francillon and M. Senn.

Thursday, September 2, 1954

Presentation of the Second Question: Surgery of the Hand.
Report of Prof. Robert Merle d'Aubigné, Paris, France, with the collaboration of Prof. Böhler of Austria; Dr. Michael Mason, Chicago, Illinois; Dr. Jean Gosset and Dr. Raoul Tubiana, Paris, France; and Mr. R. G. Pulvertaft, Derby, England.
Miscellaneous matters.
Reception at the French Embassy.
Banquet.

Friday, September 3, 1954

Closing Session of Congress.

Saturday, September 4, 1954

Excursions: Jungfraujoch, with visit to the Scientific Station; Lake of Geneva and Valais (Zermat); the Grisons (St. Moritz); Central Switzerland (Lake Lucerne), Ticino.

Arrangements for simultaneous translation (French-English, English-French) have been made through the Swiss branch of International Business Machines.

It has been suggested that arrangements for travel facilities be made early.

THE AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS

At the second Executive Session, January 28, 1954, the new President, T. Campbell Thompson, M.D., New York, N. Y., was inducted into office; and the following officers and committeemen were elected:

President-Elect: Walter P. Blount, M.D., Milwaukee, Wisconsin
Vice-President: Harold E. Crowe, M.D., Los Angeles, California
Treasurer: Jesse T. Nicholson, M.D., Philadelphia, Pennsylvania
Secretary: John R. Noreross, M.D., Chicago, Illinois
Librarian-Historian: Claude N. Lambert, M.D., Chicago, Illinois
Junior Members of Executive Committee:
Robert A. Knight, M.D., Memphis, Tennessee
Robert D. Ray, M.D., Seattle, Washington
Member of Membership Committee: Edward T. Smith, M.D., Houston, Texas
Member of Committee on Scientific Investigation: Robert A. Robinson, M.D., Baltimore, Maryland
Member of Committee on Public Relations: Robert W. Johnson, Jr., M.D., Baltimore, Maryland
Member of Program Committee on Instructional Courses: Edwin R. Schottstaedt, M.D., San Francisco, California
Member of Program Committee on Audio-Visual Education: Edward W. Cullipher, M.D., Miami, Florida
Nominating Committee:
William T. Green, M.D., *Chairman*, Boston, Massachusetts
George J. Garceau, M.D., Indianapolis, Indiana
Carl E. Badgley, M.D., Ann Arbor, Michigan
J. Vernon Luck, M.D., Los Angeles, California
John R. Cobb, M.D., New York, N. Y.

The Annual Banquet was held on Wednesday Evening, January 27, 1954, at which time the Kappa Delta Award was made. The Kappa Delta Award was given to Dr. Robert D. Ray of Seattle for his work entitled "The Development of Experimental Techniques and Their Application to Studies of Bone Growth and Metabolism".

At the first Executive Session, January 25, 1954, the following new members were inducted:

Robert C. Abrams, M.D., Baltimore, Maryland
John H. Abramson, M.D., Sherman Oaks, California
George N. Aldredge, Jr., M.D., Dallas, Texas
William S. Armour, M.D., Philadelphia, Pennsylvania
Edward G. Asherman, M.D., Portland, Maine
Orren D. Baab, M.D., Chicago, Illinois
Tyre E. Banks, Jr., M.D., Alexandria, Louisiana
Donald J. Baranco, M.D., Caldwell, Idaho
Leonard J. Barron, M.D., Binghamton, New York
Robert Bingham, M.D., Riverside, California
John D. Blair, M.D., San Francisco, California
Herbert E. Block, M.D., San Antonio, Texas
Robert W. Boal, M.D., Fort Knox, Kentucky
William Bondurant, M.D., Atlanta, Georgia
Bedford F. Boylston, M.D., Houston, Texas
Charles B. Bray, Jr., M.D., Roanoke, Virginia
Hanes H. Brindley, M.D., Temple, Texas
Alexander E. Brodsky, M.D., Houston, Texas
Frederic W. Brown, M.D., Fort Wayne, Indiana
Leland G. Brown, M.D., Muncie, Indiana

Marion G. Brown, M.D., Lexington, Kentucky
Thornton Brown, M.D., Boston, Massachusetts
Vernon M. Bryant, M.D., McKinney, Texas
Ivan W. Cain, M.D., Kansas City, Kansas
John S. Campbell, M.D., Bay City, Michigan
Faheam Cannon, M.D., Monroe, Louisiana
Lester William Carlander, Jr., M.D., Minneapolis, Minnesota
Donald P. Carpenter, M.D., Riverside, California
William U. Cavallaro, M.D., Summit, New Jersey
Howard L. Cherry, M.D., Portland, Oregon
O. Donald Chrisman, M.D., Northampton, Massachusetts
George R. Clarke, M.D., Wheeling, West Virginia
Samuel C. E. Clayton, Jr., M.D., Bayside, New York
J. Robert Close, M.D., Oakland, California
Herbert G. Cohen, M.D., Bronx, New York
Bart Cole, M.D., East St. Louis, Illinois
George W. Cook, M.D., Youngstown, Ohio
John F. Cowan, M.D., San Francisco, California
Alan R. Crain, M.D., Washington, D. C.
Lawrence Crane, M.D., Portland, Maine
John T. Croft, M.D., New York, N. Y.
Paul M. Davis, Jr., M.D., Alexandria, Louisiana
Phillip L. Day, M.D., San Antonio, Texas
Glenn A. Deibert, M.D., Reading, Pennsylvania
Philip G. Derickson, M.D., Tucson, Arizona
Arthur Devlin, M.D., Newark, New Jersey
Bernard Diamond, M.D., Waterloo, Iowa
Alvis B. Dickson, M.D., Holly Ridge, North Carolina
John J. Dobbie, M.D., Hagerstown, Maryland
Thomas J. Dring, M.D., New York, N. Y.
Thomas L. Duncan, M.D., New Orleans, Louisiana
Ernest B. Dunlap, Jr., M.D., Atlanta, Georgia
Alfred R. Earl, M.D., Mobile, Alabama
Warren H. Eddy, M.D., Worcester, Massachusetts
Harry N. Ein, M.D., Newark, New Jersey
Sanford H. Eisenberg, M.D., Washington, D. C.
Robert M. Erdman, M.D., Forest Hills, New York
Willard V. Ergenbright, M.D., Phoenix, Arizona
James D. Fisher, M.D., Springfield, Massachusetts
Charles T. Flynn, Jr., M.D., Meriden, Connecticut
Thomas M. Foley, Jr., M.D., Great Lakes, Illinois
John D. Folsom, M.D., Grand Forks, North Dakota
J. Donald Francis, M.D., Santa Rosa, California
Herman I. Frank, M.D., Bayonne, New Jersey
Carl F. Freese, M.D., Hempstead, New York
Barry A. Friedman, M.D., Cleveland Heights, Ohio
Robert L. Garrett, M.D., Vallejo, California
Webster B. Gelman, M.D., Iowa City, Iowa
Herman Gladstone, M.D., New York, N. Y.
Joesph L. Goldner, M.D., Durham, North Carolina
Morris L. Goren, M.D., Los Angeles, California
Sidney S. Grant, M.D., Los Angeles, California
Walter P. Graul, M.D., St. Louis, Missouri
Worth M. Gross, M.D., Fort Smith, Arkansas
Edward S. Grossman, M.D., Chicago, Illinois
Harle B. Grover, M.D., Texarkana, Texas
William H. Gulledge, M.D., Camp Lejeune, North Carolina
Paul G. Hafner, M.D., Longview, Washington
Innes C. Haines, M.D., Williamson, West Virginia
Richard W. Halfast, M.D., Kokomo, Indiana
Richard H. Hall, M.D., Long Beach, California
Robert F. Hall, M.D., Grand Junction, Colorado

Thomas D. Hall, M.D., Chicago, Illinois
B. Clyde Halley, Jr., M.D., Dallas, Texas
Allen E. Hamburg, M.D., Glenside, Pennsylvania
Frederick G. Hamilton, M.D., Charleston, South Carolina
Eugene J. Hanavan, Jr., M.D., Buffalo, New York
Norman M. Harris, M.D., Coos Bay, Oregon
Robert C. Hartson, M.D., Worcester, Massachusetts
Edward T. Haslam, M.D., New Orleans, Louisiana
George W. Hawkins, M.D., Santa Ana, California
Charles V. Heck, M.D., Chicago, Illinois
James A. Heckman, M.D., Huntington, West Virginia
Richard B. Herrick, M.D., Dallas, Texas
Michael J. Hitchko, M.D., Cleveland, Ohio
Boyd G. Holbrook, M.D., Salt Lake City, Utah
Milton J. Hoover, Jr., M.D., Richmond, Virginia
Robert S. Hormell, M.D., Boston, Massachusetts
Karl Horn, M.D., Brooklyn, New York
Robert M. House, M.D., Grand Island, Nebraska
Rex J. Howard, M.D., Fort Worth, Texas
Walter A. Hoyt, Jr., M.D., Akron, Ohio
Jack C. Hughston, M.D., Columbus, Georgia
John F. Hume, M.D., Tuskegee, Alabama
Robert F. Hyde, M.D., Amarillo, Texas
Mortimer Iger, M.D., Bakersfield, California
E. William Immermann, M.D., Chicago, Illinois
Alvin S. Isaacson, M.D., Los Angeles, California
S. Edward Izard, M.D., Charleston, South Carolina
G. James, M.D., Dallas, Texas
Constantine Jeannopoulos, M.D., New York, N. Y.
James A. Johnson, M.D., Colorado Springs, Colorado
Kenneth G. Jones, M.D., Little Rock, Arkansas
John J. Joyce III, M.D., Philadelphia, Pennsylvania
Robert N. Kabel, M.D., Terre Haute, Indiana
Bernard Kahn, M.D., Santa Ana, California
John J. Kalamarides, M.D., Syracuse, New York
Edward R. Kamen, M.D., Glens Falls, New York
Anthony V. Keese, M.D., San Luis Obispo, California
Frederick Koenig, M.D., Pittsburgh, Pennsylvania
Frederick J. Krueger, M.D., Milwaukee, Wisconsin
William G. Kuhn, Jr., M.D., New Brunswick, New Jersey
James F. Kurtz, M.D., La Grange, Illinois
Edward R. Lambert, M.D., Ventura, California
Donald R. Lannin, M.D., St. Paul, Minnesota
Ferdinand W. Lee, M.D., Charlotte, North Carolina
Leilas R. Lonnergan, Jr., M.D., Gadsden, Alabama
Lyon K. Loomis, M.D., New Orleans, Louisiana
Willard H. Love, Jr., M.D., Danville, Pennsylvania
Wood W. Lovell, M.D., Atlanta, Georgia
Donald B. Lucas, M.D., San Francisco, California
James A. MacDonell, M.D., Grand Rapids, Michigan
Clarence R. Martin, M.D., Houston, Texas
Harold E. Martin, M.D., Elkins, West Virginia
Harold A. Mattson, M.D., Dallas, Texas
Virgil R. May, Jr., M.D., Richmond, Virginia
Harold S. McBurney, M.D., San Francisco, California
Raymond A. McCanse, M.D., Kansas City, Missouri
Thomas R. Miller, M.D., Lexington, Kentucky
Leon H. Mims, M.D., Miami, Florida
Ralph D. Mishkin, M.D., Queens Village, New York
John S. Moore, M.D., Roswell, New Mexico
William H. Morgan, M.D., Fort Worth, Texas
Horton L. Murray, M.D., Syracuse, New York

David J. Nelson, M.D., Pocatella, Idaho
Ernest E. Neustadt, M.D., New York, N. Y.
Vernon L. Nickel, M.D., Los Angeles, California
Henry I. Okagaki, M.D., Madison, Wisconsin
David R. Oliver, M.D., San Antonio, Texas
Colman J. O'Neill, M.D., Oak Park, Illinois
Edward H. O'Phelan, M.D., Minneapolis, Minnesota
Thomas G. Otto, M.D., Cape Girardeau, Missouri
Alfred M. Palmer, M.D., San Francisco, California
Robert F. Patterson, Jr., M.D., Knoxville, Tennessee
Robert M. Paulling, Jr., M.D., Charleston, South Carolina
George V. Pendy, M.D., Detroit, Michigan
Walter R. Petersen, M.D., Champaign, Illinois
Nathan Pollack, M.D., Brooklyn, New York
John A. Powers, M.D., Charlotte, North Carolina
George N. Psimas, M.D., Beckley, West Virginia
Moses Rabson, M.D., Philadelphia, Pennsylvania
Thomas J. Radley, M.D., Cincinnati, Ohio
George T. F. Rahilly, M.D., Fort Lauderdale, Florida
Douglas E. Ramsey, M.D., Seattle, Washington
Fay M. Randall, M.D., Birmingham, Alabama
Robert D. Ray, M.D., Seattle, Washington
B. Allen Richardson, M.D., Honolulu, Hawaii
James M. Riley, Jr., M.D., Louisville, Kentucky
Sterling J. Ritchey, M.D., Hot Springs, Arkansas
Harold H. Robinson, Jr., M.D., Sacramento, California
Charles A. Rowe, M.D., Oakland, California
Earl W. Schafer, M.D., High Point, North Carolina
George E. Scheer, M.D., St. Louis, Missouri
Edward L. Schrey, M.D., Chicago, Illinois
Vincent A. Scudese, M.D., Newark, New Jersey
Max D. Shaffrath, M.D., Sacramento, California
Gordon H. Shultz, M.D., Bloomington, Illinois
Christian F. Siewers, M.D., Fayetteville, North Carolina
Harley M. Sigmond, M.D., Evanston, Illinois
John J. Silenskey, M.D., Johnstown, Pennsylvania
Richard D. Smith, M.D., Omaha, Nebraska
William S. Smith, M.D., Columbus, Ohio
William Howard Snead, M.D., Springfield, Missouri
Paul Ellsworth Spray, M.D., Oak Ridge, Tennessee
Philip L. Staub, M.D., Bridgeport, Connecticut
Clifford A. Stevenson, M.D., Bethesda, Maryland
Allan J. Stinchfield, M.D., Augusta, Maine
Carl A. Stolberg, M.D., Jackson, Michigan
Frank P. Stone, M.D., Lincoln, Nebraska
Harold Swerdloff, M.D., Los Angeles, California
Gilbert H. Taylor, M.D., New York, N. Y.
Frank W. Teague, M.D., Indianapolis, Indiana
Charles B. Thomas, M.D., Greenville, South Carolina
Edward F. Thomas, M.D., Amarillo, Texas
Kearns R. Thompson, Jr., M.D., Lexington, Kentucky
John F. Tillotson, M.D., Lima, Ohio
David G. Vesely, M.D., Birmingham, Alabama
Charles E. Vilmer, M.D., Kansas City, Missouri
Raymond C. Waisman, M.D., Milwaukee, Wisconsin
Kurt Walder, M.D., Jackson Heights, Queens, New York
Frederick S. Webster, M.D., Lincoln, Nebraska
William C. Westen, M.D., Santa Fe, New Mexico
Edward M. Wheeler, M.D., White Plains, New York
Robert O. Whitson, M.D., Baytown, Texas
Edward J. Wiater, M.D., Long Beach, California
Loyal K. Wilson, M.D., Waco, Texas

Walter L. Wood, Jr., M.D., Lynwood, California
Daniel L. Yancey, M.D., Springfield, Missouri
Chestley L. Yelton, M.D., Fairfield, Alabama
Robert S. Young, M.D., Pueblo, Colorado

The American Academy of Orthopaedic Surgeons will hold its Twenty-second Annual Meeting at the Hotel Statler, Los Angeles, California, January 29 to February 3, 1955.

BRITISH GUESTS — THE EXCHANGE FELLOWS

On April 27, 1954, five Exchange Fellows will arrive in New York City. They are: Henry Richard Hodgkinson, Sydney, Australia; Harold J. Richards, Oswestry, England; James Noel Wilson, Cardiff, South Wales; George Patrick Mitchell, Oxford, England; and Donald Brooks, Dublin, Eire.

The American Orthopaedic Association will share with The Canadian Orthopaedic Association the arrangements for their scientific entertainment. During the time the Exchange Fellows are here, their visit will be limited to the eastern part of the continent in order to conserve time and funds.

The tentative program is as follows:

April 27: Arrival in New York, N. Y.;
May 16: Travel by train to Wilmington and Philadelphia;
May 21: Travel by train to Baltimore and Washington;
May 29: Travel by train to Montreal;
June 1: Travel by train to Toronto;
June 5 and 6: Travel by car (via Niagara Falls) to Bretton Woods, New Hampshire;
June 7 to 10: At Bretton Woods for the Annual Meeting of The American Orthopaedic Association. The Exchange Fellows will be the guests of the Association.
June 10: Travel by car to Boston;
June 15: Travel by train to New York whence they will embark for England on June 16.

A select list of medical films, all 16-millimeter (some silent; some with sound), available only to professional audiences, may now be obtained free of charge upon request from The Princeton Film Center, Inc., Princeton, New Jersey.

The **Third International Poliomyelitis Conference** will be held September 6 to 10, 1954, at the Orthopaedic Clinic, University of Rome, Italy. The meetings are being sponsored jointly by the University of Rome (Italy), the National Foundation for Maternity and Child Care (Italy), and the National Foundation for Infantile Paralysis (United States of America).

Requests for hotel accommodation and requests for information concerning the Conference should be made to the Secretariat of the Third International Poliomyelitis Conference, 6 via Lucullo, Rome, Italy (the cable address: Inpolio, Rome).

DISCUSSION

Pantalar Arthrodesis

(*Continued from page 362*)

Dr. Hunt (closing): I would like to thank Dr. Patterson and Dr. Joplin for their interesting review of pantalar arthrodeses in their hospitals and for their kind remarks. Our venture into this method of ankle fusion and triple arthrodesis at one sitting was not without hesitation, as our teaching had always been toward a conventional two-stage procedure for the reasons given by Dr. Patterson. "Seeing is believing", however, and Dr. Thompson convinced me years ago that, if a pantalar fusion is indicated, a two-stage procedure is an unnecessary waste of time and money. The procedure has been used in six more cases since the completion of this study, all of which give added conviction to the conclusions drawn.

Book Reviews

THE PHYSICIAN IN ATOMIC DEFENSE. Atomic Principles, Biologic Reaction, and Organization for Medical Defense. Thad P. Sears, M.D., F.A.C.P. Chicago, The Year Book Publishers, Inc., 1953. $6.00.

Probably all physicians know something about radio-activity and isotopes, their use, and radiation dosage and damage. From articles in the *Journal of the American Medical Association* and in state medical journals, from publications of the United States Civil Defense Administration, such as Health Services and Special Weapons Defense (AG-11-1), as well as bulletins from their State and local Civil Defense organizations, every physician is aware of the hazards of atomic bomb bursts and knows that he will have to play an important role in the development of adequate defense plans and, should atomic warfare become a horrible reality, in the care of casualties. He knows about radiation sickness, the care of traumatic injuries and burns, but it is doubtful if he has any conception of the magnitude of the problem or of the astronomical number of casualties that he will be called upon to treat.

The Physician in Atomic Defense by Dr. Thad P. Sears is intended to inform and to educate the average physician on this subject. The chapters proceed in a logical manner from a simple elucidation of the atomic structure, through an explanation of radio-activity and its part in the atomic age, to the consideration of the clinical, biological, pathological, and therapeutic aspects of atomic warfare. The book closes with a description of the organization of a medical department for atomic defense and a short outline of accepted treatment.

The author has presented the complex chemical and physical concepts of atoms, of radio-activity, and of electromagnetic waves in simple language which should be easily understood by any physician. The chapters on the organization of a medical department for atomic defense follow the United States Civil Defense Manual, as would be expected.

The value of this book lies in the fact that the author has collected in one volume all the essential information relating to the atomic bomb, the chemical and physical theories and laws which govern its production, the clinical and pathological effects of a bomb burst and reasons for them, the methods of treating these effects, and the necessity for organizing to mitigate this potential hazard. This is all presented in a logical factual manner without dogmatic assertions, and the reader is left to draw his own conclusions.

Any physician who has been out of medical school for fifteen years will benefit from the early chapters and all physicians who are not active in Civil Defense will gain a better understanding of the atomic-bomb hazard and the necessity for Federal, State, and community organization for Civil Defense through it.

MASSAGE AND REMEDIAL EXERCISES IN MEDICAL AND SURGICAL CONDITIONS. Ed. 9. Noël M. Tidy, Member of the Chartered Society of Physiotherapy, T.M.M.G. Baltimore, The Williams and Wilkins Company, 1952. $6.00.

This textbook is far more than a treatise on massage and exercise. The author takes up in detail not only orthopaedic and neurosurgical diseases but medical and general surgical conditions as well. After discussing the general medical and surgical treatment, the author outlines the physical and medical aspects of treatment with great care. The various types of treatment of each topic under discussion are taken up in order, from the acute stage through the convalescent stage to the late or chronic stage. The "do's" and "don'ts" of the various modalities of physical therapy are well outlined for each stage.

This work should be of great interest and help to any physician. To physical therapists especially, study of this book should give an understanding of the patient's disease, its etiology and complications, thereby aiding them in its treatment.

ATLAS OF CROSS SECTION ANATOMY OF THE BRAIN. Guide to the Study of the Morphology and Fiber Tracts of the Human Brain. Fifth Section of Emil Villiger's *Brain and Spinal Cord* (Ed. 14. Revised by Eugen Ludwig). Atlas revised by A. T. Rasmussen. New York, The Blakiston Co., 1951. $5.00.

One of the standard European texts of neuro-anatomy has for many years been Emil Villiger's *Gehirn und Rückenmark*, now in its Fourteenth Edition, as revised by Eugen Ludwig. The fifth section of this work contains plates, drawn by Dr. Villiger, of Weigert-stained anatomical preparations from the collection at the University of Basel.

In order that this valuable neuro-anatomical teaching material might be more easily available for study, Benno Schwabe & Company, Basel, have released the plates for a separate issue of an atlas, and A. T. Rasmussen, Professor of Anatomy, University of Minnesota, has undertaken to expand and to supervise the publication.

To Dr. Villiger's collection of transverse sections of the brain, Dr. Rasmussen has added a series of representative sagittal preparations. While these reproductions do not show quite the fine artistic detail found in Villiger's series, their inclusion is invaluable. Reference to both the transverse and sagittal views of a given area allows for the creation of a "three-dimensional" concept of the localization of important intracranial anatomical structures.

This book can be highly recommended and should be included in all medical library collections.

PHYSICAL FOUNDATIONS OF RADIOLOGY. Ed. 2. Otto Glasser, Edith H. Quimby, Lauriston S. Taylor, and J. L. Weatherwax. New York, Paul B. Hoeber, 1952. $6.50.

For some time the Second Edition of this book has been impatiently awaited. Written by the foremost living American roentgenological physicists, the First Edition has been for ten years not only a standard textbook but an indispensable guide to all roentgenologists and to persons working in allied fields. Because of the rapid progress made in roentgenological physics in the past decade, the need for enlarging the book and bringing it up to date has been apparent. The new edition amply meets the public demand.

The authors have revised many chapters and have added a wealth of new material dealing largely with radio-active isotopes and problems arising from the ever changing sphere of radio-activity and radiation effects. They have included measurements and dosage calculations, high-energy acceleration, and super-voltage generation.

The fundamental concepts of matter and radiation and their interaction, as well as the basic features of electricity and magnetism which were described in the First Edition, have been added to, and many new ideas have been integrated. The same is true of the chapters on physical factors of roentgen-ray tubes, circuits and generators, the complicated problems of quantity and quality of radiation and tissue dosage, and the concepts of radium therapy with calculation of dosage and methods of application.

Of great interest to many will be a new chapter pertaining to the diagnostic problems of roentgenology.

The concluding chapter which is concerned with the biological interaction of radiation and protection from it enlarges considerably on data published in 1944. An appendix, with dosage charts for radiation with half-value layers ranging from 0.5 millimeter Al. up to 8 millimeters Cu., and an excellent index add tremendously to the value of the work.

This book is written primarily for roentgenologists, physicists, and biologists. To them, this Second Edition of an old friend will be more than welcome; for many others working with radiation problems, it will prove an indispensable addition to their required reading.

RHEUMATIC DISEASES. Diagnosis and Treatment. Eugene F. Trout, M.D., F.A.C.P. St. Louis, The C. V. Mosby Company, 1952. $20.00.

A broad and ambitious approach to the problems of rheumatic disease is made in this book. Its nearly 900 pages are divided into fifty-one chapters which discuss from varying points of view the manifold conditions included in the currently accepted Classification of Rheumatic Diseases of the American Rheumatism Association. The major portion of the book has been written by the author, and certain specialized chapters have been written by other qualified authorities. Such chapters as "The Skin in Rheumatism" and "The Ocular Manifestations in Rheumatic Diseases" contain valuable information, which is well presented.

Generally detailed discussion of the pathology and clinical manifestations of the "connective-tissue diseases" is provided. It is somewhat surprising to find that no mention is made of the surgical treatment of rheumatic heart disease, although other aspects of treatment are described.

In appraising a book of this scope, one must not be unduly influenced by rare omissions, minor typographical errors, or occasional adherence to currently unpopular beliefs by the author. The book as a whole represents a competent exposition of a controversial group of diseases. Varying views of etiology and treatment are presented, and the references are extensive. With regard to the treatment of rheumatoid arthritis, the author agrees in most respects with the comprehensive approach advocated by the American Rheumatism Association in its valuable *Primer on the Rheumatic Diseases*. In his recommendation of vaccine therapy, however, he is definitely in disagreement with the *Primer*, which includes the use of vaccines with the "measures that are of doubtful value or useless". It is unfortunate that the author does not present statistical studies of large numbers of patients followed for long periods of time in evaluating vaccine and other types of treatment. This book, along with most other monographs on the rheumatic diseases, emphasizes the need for such a study of the subject, which must often seem to become more confusing day by day.

The chapter "Psychologic Factors in Rheumatoid Arthritis" is reprinted from an article which appeared in *Psychosomatic Medicine* in 1947. It is laudable that attention be focused on this important aspect of rheumatoid arthritis and other rheumatic diseases. Since, however, the article was a preliminary report and the tentative conclusions are not fully accepted by some other workers in this special field, one must question the wisdom of including it in a book of this type. The student or physician seeking help in understanding patients with rheumatoid arthritis might be given more convincing evidence of the importance of psychological factors if the subject were handled by an authority on rheumatoid arthritis whose experience with patients had provided the material for the chapter.

SURGERY OF TRAUMA. Edited by Colonel Warner F. Bowers, Medical Corps, United States Army. Philadelphia, J. B. Lippincott Company, 1953. $15.00.

This volume is a well organized and integrated reference to present concepts of the pathophysiology and treatment of traumatic disorders. Correlated and edited by a student of the effects of injury on specific body tissues, it traces the advances in our knowledge of this subject and emphasizes the significant gaps which remain.

Section One, dealing with general body responses to trauma, considers the various etiological agents and includes an extremely informative and current evaluation of the effects of ionizing radiation. There is a comprehensive description of metabolic changes incidental to wound shock and an adequate consideration of the general subject of wound infection.

Section Two presents regional wound surgery as described authoritatively by experts in their respective specialties. No field of surgical trauma is overlooked, and the material has been freshly prepared and conservatively presented. Controversial forms of management are placed in proper perspective, and a successful attempt has been made to direct the younger surgeon in the more accepted therapeutic channels in each field. This in itself deserves high commendation.

Section Three calls attention to strictly military considerations in traumatic disturbances and is especially valuable in the indoctrination of the civilian physician into the contingencies of war surgery. There is a need for such information to acquaint the newly inducted (however well trained) surgeon with peculiar situations which necessarily modify thinking and action in the treatment of mass battle casualties. Specific therapeutic recommendations in the management of regional war injuries are direct and unequivocal.

Section Four is an effort by the editor to emphasize the fluidity of present concepts of the nature and effects of surgical trauma in the hope that others will be stimulated to further research.

There are excellent subject and bibliographical indexes, and many of the contributors have added extensive lists of references.

This book is worthy of study by civilian and military surgeons alike as a much needed correlation of basic pathophysiological reactions with clinical problems in the surgery of trauma. For the young surgeon specializing in this field, it is a dependable and conservative guide; for the civilian physician who is entering a period of military service, it fills effectively an unfortunate void. The emphasis is constantly on underlying principles and therapeutic essentials. There is no attempt to make this work an encyclopaedia of traumatic disease.

CONDUCTION ANESTHESIA. Ed. 2. George P. Pitkin, M.D., F.A.C.S., F.I.C.A. Edited by James L. Southworth, M.D., F.A.C.S., Robert A. Hingson, M.D., F.A.C.A., F.I.C.A., F.I.C.S., F.R.C.S., and Winifred M. Pitkin, M.A. (Oxon.), B.M., B.Ch. (Oxon.), M.R.C.S. (Eng.). L.R.C.P. (Lond.), M.D. Philadelphia, J. B. Lippincott Company, 1953. $22.50.

The Second Edition of Dr. Pitkin's exhaustive book *Conduction Anesthesia* retains the original plan and follows the basic concepts which characterized the First Edition. The clear and detailed descriptions of techniques, illustrated by numerous diagrams and photographs, are essentially unchanged. New chapters on the Vertebral Canal and Its Contents, on Topical and Refrigeration Anesthesia, and on the Complications of Conduction Anesthesia have been added. Revision and re-writing of the sections on the Autonomic Nervous System, Clinical Pharmacology of Local Anesthetics, and Spinal Anesthesia have increased their timeliness and value. Expansion and re-arrangement of the Table of Contents have made the book more readily usable.

This book is of great value as a reference work, especially for libraries, and for surgeons and anaesthesiologists interested in regional anaesthesia. The fact that, in many instances, several methods are described for performing a given block may prove confusing to the beginner.

HAROFÉ HAIVRI. The Hebrew Medical Journal. Volume 2–1952. Moses Einhorn, Editor.

With this issue The Hebrew Medical Journal commemorates its twenty-fifth anniversary. In two editorials the past achievements and future aims are reviewed. It has been the purpose of this little publication to rectify what the editors regarded as "the paucity of medical terminology in the Hebrew language". After twenty-five years they may justifiably conclude that they have succeeded in their task.

Of interest in this issue, which contains articles in both English and Hebrew, are historical studies such as an article on "The Belief in the Curative Powers of Precious Stones among the Jews", as well as reviews on the problems of mental retardation and of hypertension. A Table of Contents of the issues published during the past quarter century is also included.

SPORTSCHÄDEN UND SPORTVERLETZUNGEN. 2. Aufl. (Neue Deutsche Chirurgie, Band 58.) Prof. Dr. med. Burghard Breitner. Stuttgart, Ferdinand Enke Verlag, 1953. DM 27.

The first part of the work discusses in general terms the injuries to which the various organic systems of the body are liable in consequence of participation in sports. The larger part of the work, over two thirds, is devoted to a discussion of the different sports and the specific injuries which may be considered as characteristic of participation in these.

No attempt is made to describe the mechanism or the treatment of these specific injuries. This, undoubtedly, accounts for the fact that there is relatively little difference between the First and the Second Editions. Apart from a few new illustrations and a distressingly slight reference to the large literature which has accumulated between the years 1937 and 1953, the work is essentially a reprint of the earlier volume. Those who do not possess the First Edition will find the present one a desirable, if not an essential, addition to their orthopaedic library.

DIE KREUZSCHMERZEN DER FRAU. Ihre Deutung und Behandlung. Gynäkologische Orthopädie. Prof. Dr. H. Martius. Stuttgart, Georg Thieme Verlag, 1953. DM 19.50.

Orthopaedic surgery is often indebted to other medical specialties. In this instance a most practical book on sacral pain in women has been written by a gynecologist. This is one of the most common complaints registered in a clinic for women. Roughly, a third of the patients complained of sacral pain, a third described such pain on questioning, and a third did not have sacral pain. On investigation the sacral pain in about 50 per cent. of the patients will be found to have a gynecological cause and in 50 per cent. an orthopaedic cause (in the majority of these the cause is static insufficiency). The author reviews the innervation of the supporting structures of the low back and of the pelvic organs. In the pain zone, the autonomic nervous system plays an important part. Uterine displacements usually do not cause sacral pain without other lesions unless the uterus is fixed in malposition. Endometriosis often causes this type of pain associated with dysmenorrhoea. The supporting and ligamentous apparatus of the pelvic organs play an important role in causing pain, particularly during and after pregnancy, sometimes associated with relaxation of the pelvic joints. The relaxed protruding abdominal wall with increased lordosis and tilting of the pelvis are the chief causes of decompensation. Flat-foot occasionally causes sacral pain. The congenital anomalies of the lumbar spine and pelvis are reviewed, as well as the diseases of the skeleton and articulations. Diagnosis should not be made on roentgenographic examination alone, but only after careful physical examination. The book is well illustrated, and there is an adequate bibliography. This is a careful study of low-back pain in women and should be of great value to both the gynecologist and the orthopaedic surgeon.

ZEITLOSES UND ZEITGEBUNDENES IN DER CHIRURGIE. Prof. Dr. Rudolf Nissen. Stuttgart, Georg Thieme, 1952. DM 2.

This is the inaugural dissertation of the author on his assumption of the Chair of Surgery at Basel, Switzerland. It is a philosophical discussion of the progress of surgery and its probable future trends. All surgery must be regarded as a therapeutic portion of medicine in general. The author discusses at length the influence of German medicine upon scientific progress, particularly in North America, from the middle of the last century until the nineteen-twenties, when scientific initiative was snuffed out. He mentions with pride the giants in Swiss surgery,—Billroth, Kocher, and Sauerbruch. The great reformers of modern surgery are not surgeons but biochemists and clinicians who have investigated such factors as water and electrolyte balance, metabolism, antibiotics, and bacteriostatics. In order to progress, surgery must be schooled in the observations of innumerable theoretical investigations.

WIEDERHERSTELLUNGSCHIRURGIE UND TRAUMATOLOGIE, JAHRBUCH; RECONSTRUCTION SURGERY AND TRAUMATOLOGY, ANNUAL SURVEY; CHIRURGIE RÉPARATRICE ET TRAUMATOLOGIE, ANNUAIRE. VOL. I. Max Lange, Editor. Basle, S. Karger, 1953. Swiss francs 36.

This volume of 262 pages is the first of a proposed series of annual surveys of reconstruction surgery and traumatology. It is the purpose of the editors to make available in one volume a record of progress in the entire field as it is concerned with the locomotor system.

The material has been divided into three separate sections, each being devoted to one of the major advances in this field during the past few years. The first section deals with the general subject of the "Value and Limits of Intramedullary Nailing". Three of the four articles included are written in easily readable German, and the fourth article is written in English.

The second section deals with "Aseptic Necrosis of the Femoral Head Following Nailing". Five of the six articles in this section are written in German; one is written in French.

The third section of the book is concerned with the "Treatment of Irreparable Nerve Paralyses". Of the two articles in this section written in German, one is by Arthur Steindler of Iowa City. Three articles in English deal with the reconstruction of the hand following severe nerve injuries in the forearm. The one article written in French by R. Merle d'Aubigné describes his method of tendon transplantation for the repair of radial-nerve paralysis.

The type is large enough and the work is so clearly printed that the reading of the text is made easy. The illustrations are well selected and are beautifully reproduced, but a few more illustrations would have improved some of the articles published in this volume.

The attempt to present adequately each of the three major subjects in each of three languages has not been entirely successful. Nevertheless, this small year book will be of considerable help to surgeons in the various countries throughout the world.

COMPRESSION ARTHRODESIS. Including Central Dislocation as a Principle in Hip Surgery. John Charnley, F.R.C.S. Edinburgh, E. & S. Livingstone Ltd., 42 shillings; Baltimore, The Williams & Wilkins Company, 1953. $8.50.

This monograph on compression arthrodesis by Mr. John Charnley is an excellent presentation of the subject considered from a clinical point of view. The subject of compression is presented, and the reasons to justify or condemn the use of compression as it influences bony union are reviewed. It is the author's convic-

tion that compression of cancellous bone results in faster and more complete bony union than when compression is omitted. He does not feel convinced that compression of cortical bone in the treatment of fractures leads to earlier or better union. This conviction influences the consideration given the discussion of osteoclasis as opposed to osteogenesis under compression.

The microscopic sections removed from patients undergoing compression arthrodesis of the knee to enable a study of their clinical progress are indeed beautifully done. The micro-x-rays give much information concerning the healing structure in cancellous bone. The microscopic sections show the process of osteogenesis, the laying down of bony lamellae, and the behavior of collagenous materials in bone formation. The network of this bone formation is described as woven bone, and its behavior in osseous union is outlined. The study does not, however, give information concerning osseous activity previous to four weeks postoperatively.

In order to have areas of variable pressure, knee fusions were performed, irregular surfaces being used. It is the author's conviction that the greater the pressure on an area, the better the healing. The upper limit of the high pressure has not been determined. On producing pressure, it is necessary to eliminate the shearing forces for maximum pressure effect.

The mechanical forces employed in compression arthrodesis of the knee and the manner in which they are affected by the construction of the clamps and the materials from which the pins are manufactured are discussed by Mr. J. A. L. Matheson. The distribution of the pressure on the bone surfaces is discussed from an engineering point of view.

After presentation of this material, the author describes the design for the most efficient type of arthrodesis. This might be said to be "Destruction of the Natural Centre of Motion, the Establishment of Bone Block and the Use of Fibrous Ankylosis as a 'Second Line of Defence'".

The technique of compression arthrodesis of the knee is described in detail. The over-all success of the technique as seen in final results and absence of postoperative complications is stressed. Charts of the results, including failures, in different types of affected bone are presented and give an honest clarity to the subject.

Mr. Charnley also describes the technique for compression arthrodesis of the shoulder, ankle and tarsal joints, elbow and finger joints, and the hip.

Fusion of the hip is accomplished by central dislocation in which procedure the head is forced through the acetabulum and is held in this position under compression by means of a special spring clamp. This is a major procedure and can be quite difficult. The reviewer had the opportunity to observe and to examine with Mr. Charnley a number of the patients subjected to this procedure; even though the affected leg was shorter, the patients did not complain of pain or distress.

The chapter on arthroplasty of the hip joint seems superfluous.

This monograph deserves consideration by anyone interested in compression arthrodesis. It lacks, as do many clinical studies, a certain completeness, but it is a valuable addition to the study of mechanical-compression effects on osseous healing about which we must learn more. This carefully presented monograph is well worth the time that the reader may spend in the study of the material.

DISEASES OF MUSCLE. A Study in Pathology. Raymond D. Adams, M.A., M.D., D. Denny-Brown, M.D., D. Phil., F.R.C.P., and Carl M. Pearson, M.D. New York, Paul B. Hoeber, Inc., 1953. $16.00.

This is a timely and valuable addition to the medical literature. The authors have made an extensive review of the vast literature on this subject and have synthesized this with the results of their own considerable clinical and experimental work to produce a volume of 544 text pages which contains in readily accessible form a tremendous amount of information of value to all concerned with musculoskeletal diseases.

Contrary to the implication of its title, the book does not concern itself strictly with pathology. It reviews the embryology, anatomy, biochemistry, and neurophysiology of skeletal muscle in Part One, while in Part Two the text deals with experimental pathology and the general reactions of human muscle to disease. In Part Three, specific pathological entities are considered, including congenital defects, the dystrophies, inflammatory diseases, tumors, traumatic and circulatory lesions, spinal and neural atrophies, and a wide variety of diseases which are grouped under the heading "Miscellaneous Diseases". These include myasthenia gravis, periodic paralysis, and many others. In a final chapter, the differential diagnosis and methods of pathological study are presented. The book abounds with beautiful black-and-white reproductions of photomicrographs, as well as reproductions of electromyograms and illustrative diagrams.

In general, this reviewer can offer nothing but praise for this book. In some instances the legends for the photomicrographs do not seem to identify the lesion as clearly as one might wish. An arrow or other identifying mark would guide the less pathologically trained eyes of some readers. However, such a minor defect does not detract from the over-all excellence of this work. It is recommended highly to all concerned with neural and muscular disease.

DIE ANWENDUNG DER STATIK AUF DEN MENSCHLICHEN BEWEGUNGSAPPARAT. Prof. Dr. med. Hans Storck. Stuttgart, Ferdinand Enke Verlag, 1951. DM 13.

This essay on the science of balance in human locomotion begins with a pertinent exposition of the

historical background and ends with conclusions for practical application in the practice of orthopaedic surgery.

Prof. Storck reduces the locomotion process to single static (balanced) positions by constructing these on a model and asking: What forces are necessary in the working together between outer forces (forces of gravity) and inner forces (muscle forces) in order to attain such positions?

Beginning with Otto Fischer's principal point, the author establishes the basis for recognizing motion as a connecting factor between time and space and also between matter and force, and he concludes the introduction with convincing statements regarding the significance of the investigations of statics (balance) in orthopaedics.

In a scholarly and lucid text, these principles are applied to the author's original models, and with the aid of fifty-seven excellent illustrations he explains the muscle tensions on the standing weighted foot, the form of the calcaneus as product of the forces operating on it, the function of the knee joint with paralysis of the quadriceps, and indications for quadricepsplasty.

On every page of this monograph, Prof. Storck effectively focuses attention on the principles underlying the normal function of muscles and on the accurate evaluation of disability. He proposes a valid basis for treatment. The reader can profit by companionship with this impressive work.

Professor Storck has made a contribution which should soon be available in English. Application of his views could stimulate current investigations in this country and provide a new basis for the more accurate evaluation of functional disabilities, with a corresponding modification of present treatment to give better functional results.

OPERATING ROOM TECHNIC. Ed. 4. St. Mary's Hospital, Rochester, Minnesota. Philadelphia, W. B. Saunders Co., 1952. $6.50.

This book, written originally in 1924 to instruct nurses and assistants at St. Mary's Hospital, Rochester, Minnesota, has been completely rewritten and brought up to date. New surgical procedures are described, and sections on urology and peroral endoscopy have been included. The book describes first the operating room at St. Mary's and then describes in outline form the positioning and draping of the patient, instruments, drains, suture material, and the basic steps in the common surgical procedures used in general surgery, orthopaedics, neurosurgery, urology, and peroral endoscopy. In addition there are sections on such special procedures as spinal anaesthesia and vein exposure. A chapter is also given to a listing of the duties of various members of the surgical team. Finally there is a chapter dealing with the educational program for nurses at St. Mary's and an appendix describing linens and other surgical supplies, including an illustrated index of surgical instruments.

The book is profusely illustrated with black-and-white photographs and drawings. These are on the whole of fine quality, but, inasmuch as the book is written primarily for nurses early in training, many of the illustrations depicting parts of the operative procedures have such scanty legends that it seems unlikely that they will be understood by the majority of the readers.

DIE WIRBELSÄULENTUBERKULOSE UND IHRE DIFFERENTIALDIAGNOSE. (68. Ergänzungsband der "Fortschritte auf dem Gebiete der Röntgenstrahlen vereinigt mit Röntgenpraxis".) Dr. J. E. W. Brocher. Stuttgart, Georg Thieme Verlag, 1953. DM 78.–.

This 255-page volume by Dr. J. E. W. Brocher of Geneva, Switzerland, deals with the problem of the differential diagnosis of tuberculosis of the spine. He discusses spinal tuberculosis at considerable length and follows with discussions of some of the diseases of the spine which might simulate it. Among these are nontuberculous infectious spondylitis, ankylosing spondylitis, Scheuermann's disease, Calvé's disease and other similar disorders, congenital lesions, and conditions associated with osteoporosis and osteosclerosis.

Although the work is mainly concerned with the interpretation of the rontgenographic features of the disease described, clinical data are also included.

The author stresses the importance of early correct diagnosis. The planigram is suggested as one of the aids in the early discovery of the lesions. Dr. Brocher states that the diagnosis of spinal tuberculosis is frequently missed and estimates that in the past thirty years a false diagnosis has been made in some 25 per cent. of the cases. He also makes the statement that every tenth patient treated for spinal tuberculosis actually did not have the disease.

The book contains 376 illustrations of which the greater portion are roentgenograms reproduced in reverse. This reversal might to some people reduce their value as illustrations. They are used to emphasize the various points with which the author deals.

The book is written in German and thus its American readership is limited. Although it covers the subject fairly well, the material contained therein is probably already familiar to most orthopaedic surgeons.

THE MEDICAL ANNUAL. A Year Book of Treatment and Practitioners' Index. Sir Henry Tidy, K.B.E., M.A., M.D. (Oxon), F.R.C.P., and A. Rendle Short, M.D., B.S., B.Sc., F.R.C.S., Editors. Bristol, John Wright and Sons, Ltd., 1953.

The Medical Annual for 1953, like its predecessors, again offers useful brief summaries highlighting the

chief accomplishments in medicine and surgery during the past year. This volume, the Coronation Number, also contains a historical section of interest on "Medicine in the Reign of Elizabeth I".

For the most part, the various orthopaedic subjects have been summarized by Philip Wiles; it would hardly be possible to deal more concisely and informatively, in the brief space allotted, with such complex subjects as low-back pain, bone and joint tuberculosis, acute osteomyelitis, and similar topics.

As in previous years, the book contains a "Practitioner's Index" of pharmaceutical and dietetic preparations and of appliances, as well as a list of British and American medical works published during the previous year.

SHOULDER LESIONS. Ed. 2. H. F. Mosely, M.A., D.M., M.Ch. (Oxon.), F.R.C.S. (England and Canada), F.A.C.S. New York, Paul B. Hoeber, Inc., 1953. $12.00.

The Second Edition of this book has been carefully revised and enlarged. The many colored illustrations are noteworthy for their precision, clarity, and definition. The illustrations of Helen MacArthur and those contributed by Dr. Frank Netter will prove invaluable both to the inexperienced and the experienced surgeon in interpreting the gross findings seen at operation.

New chapters have been added, and evidence is given of the author's extensive experience by the excellent descriptions of the various techniques for repair of rotator-cuff ruptures.

The chapters on dislocations and fractures of the proximal end of the humerus contain many excellent black-and-white illustrations, as well as numerous reproductions of roentgenograms.

This reviewer believes that Dr. Moseley, in view of our present-day knowledge of recurrent dislocations of the shoulder, overemphasizes the value of the Nicola procedure by devoting a full page to the illustration of the operative procedure in addition to the description in the text. The Vitallium-rim procedure for recurrent dislocation, as described by Moseley, appears to have considerable merit, especially in epileptics.

The reviewer does not think resection of the outer portion of the clavicle should be the recommended procedure in treatment of fractures of the outer end of the clavicle or of dislocation of the claviculo-acromial joint, recent or old. There are other operative procedures which are more efficacious; and, when they are performed, the continuity of the clavicle can be re-established, shoulder function restored, and the integrity of the claviculo-acromial joint maintained.

The organization of the chapters on fibrositis and the stiff and painful shoulder leave the reader a bit confused. There is still considerable doubt in the reviewer's mind whether there is a specific entity that should be called "fibrositis of the shoulder". The differentiation between a true frozen shoulder and a stiff and painful shoulder is not too clear.

The descriptions of the use of cortisone in the treatment of frozen shoulder and hydrocortone injections in the subdeltoid bursal area for treatment of acute calcified tendinitis is timely.

The chapters on the neurological aspects of the shoulder lesions, written by Francis L. McNaughton, and the chapter on x-ray diagnosis and treatment, written by Carleton B. Peirce and Jean Bouchard, are valuable additions to this book. Although the latter authors stated that they have had no personal experience with arthrography as an aid in the diagnosis of ruptures of the rotator cuff, some mention of its technique might have been helpful, since this procedure certainly has a place in the determination of uncertain musculotendinous cuff ruptures.

The few minor criticisms of this book should not detract from its practical value, for this is one volume which should be in the library of every orthopaedic and traumatic surgeon.

LEIBESÜBUNGEN MIT KÖRPERBESCHÄDIGTEN. Band II. Hans Lorenzen. (Arbeit und Gesundheit neue Folge Heft 51.) Stuttgart, Georg Thieme Verlag, 1953.

The first volume of this compact little work was reviewed in *The Journal* in October 1951. The present volume not only discusses the various types of athletic activities for the handicapped in greater detail, again with many vivid photographs, but also offers an exact standardization of the achievements possible and desirable for each type and degree of disability, particularly amputations. Two leaflets enclosed with this monograph list a number of tests set up by a national athletic association for the handicapped. Distance and speed requirements are listed for each type of amputation; under swimming, for example, the different classes of achievement are listed for participants over forty, those under forty, lower-extremity amputees, leg amputees, foot amputees, and others, and the speed and distance requirements are given in each case.

The psychological as well as the physiological value of such rehabilitation measures cannot be stressed too much; by being thus identified with a group, the individual amputee or handicapped person gains inestimably in morale and hence increases his capacity for progressive achievement.

DIE BEHANDLUNG DER KNOCHEN- UND GELENKTUBERKULOSE. Dozent Dr. med Heinz May. Stuttgart, Ferdinand Enke Verlag, 1953. DM 30.

This volume presents a thoroughly common-sense approach to the treatment of bone and joint tuber-

culosis as local manifestations of a generalized disease process. The first half of the work is concerned with an excellent discussion of the pathogenesis, pathology, diagnostic procedures, and the various forms of treatment of skeletal tuberculosis in general. The more commonly used tuberculostatic drugs are reviewed, and their application in the treatment of closed tuberculous lesions, mixed infections, and open lesions with sinus-tract formation is discussed. The combined chemotherapy of two or more of these tuberculostatic agents is described; but, in the absence of a sufficiently long follow-up, the importance of other forms of treatment, and especially surgical therapy, is emphasized.

The second half of the volume is concerned with a description of tuberculous manifestations in different portions of the skeleton. The larger part of this portion of the work is devoted to tuberculosis of the spine and the hip joint. Even admitting the greater preponderance of these localizations, it seems as if the manifestations of tuberculosis in the tarsus, carpus, elbow, knee, and shoulder have been dismissed with disproportionate brevity. Nevertheless, this book must be considered of definite interest and will be highly regarded as a general survey of the condition.

DIHIDROESTREPTOMICINA Y TUBERCULOSIS OSTEO-ARTICULAR. Alvaro Lopez Fernandez. Valencia, Editorial Saber, 1953.

In this monograph is reported a careful clinical and roentgenographic study made of the effect of streptomycin upon osteo-articular tuberculosis at the National Maritime Sanitorium of Maloarrosa. One hundred patients were studied with 107 osseous lesions. Eighty-four of these lesions were classified as caseous and seventeen as granular. The author gave 0.25 to 0.5 gram of streptomycin intramuscularly daily, the dosage depending upon the age of the patient. After 30 grams had been given, the drug was omitted for one month. In addition, streptomycin was injected into infected joints and into abscess cavities, when this could be accomplished easily. Penicillin was employed in the presence of secondary infection. The author found that tuberculous abscesses wherever located followed a favorable course after the use of streptomycin. A few vertebral abscesses, chiefly in the thoracic region, responded slowly, as did subchondral osseous erosions. Roentgenographic examination revealed a good response in caseous lesions, but granular lesions seemed to be unmodified, as seen by roentgenograms, in two thirds of the patients. A fall in the erythrocyte sedimentation rate was the earliest finding after streptomycin had been given; it fell initially in all patients who were treated. Streptomycin did not influence the postoperative course or surgical repair. The drug seemed to act only on the *Mycobacterium tuberculosis*. The general condition of the patient improved under this therapy. No intolerance to the drug was observed and there were no local accidents. Resistance to streptomycin was observed only in the presence of secondary infection. The author felt that streptomycin was indicated in all cases of osteo-articular tuberculosis, regardless of the state of evolution of the lesion.

GRUNDLAGEN DER STRAHLENTHERAPIE. Physik, Biologie und allgemeine Therapie. Prof. Dr. Richard Kurt Kepp Stuttgart, Georg Thieme Verlag, 1952. DM 38.

This textbook on radiation therapy represents an interesting approach to a subject which has been discussed by many authors.

The point of chief interest lies in the fact that Kepp is not a roentgenologist or a radiation physicist, but a gynecologist. The book, therefore, reflects largely the viewpoint of a clinician rather than a radiation specialist.

It is divided into two major portions. The first deals with the physical background of radiation therapy, including many of the most recent developments, and the usual discussion concerning electricity, the generation of radiation, and their interaction. In addition, there are chapters on therapy with radium and with radio-active isotopes. The author exhibits a knowledge of the physical background of radiation therapy not usually found among his clinical colleagues.

The second section offers a somewhat uncommon approach to the teaching of roentgenological problems. It is concerned largely with the biological effects of radiation and the general medical problems of therapy. While no attempt has been made to discuss in detail treatment of all the different diseases and of the various organs, considerable information will be found regarding biological reaction in general and of certain tissues in particular. For example, radiation effects on skin, bones, and blood are described; the tolerance dose of certain tissues and organs (such as the bladder and rectum), radiosensitivity, reaction of various types of tumor, and methods of applying radiation (single *versus* fractionated dosage) are clearly presented and well illustrated with charts and sketches. There is a complete and excellent index.

Kepp's method of presentation differs greatly from that of the usual textbook author, and it seems to the reviewer to be more informative and, therefore, more valuable. His book occupies a somewhat unique position among the many textbooks on radiation therapy because of its approach, which is definitely clinical but without shortcomings in the physical, engineering, or general radiation background. To those whose understanding of the German language is adequate to master the text, the book is highly recommended.

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Acta Anaesthesiologica Belgica (Bruxelles), **4:** No. 2, 1953.
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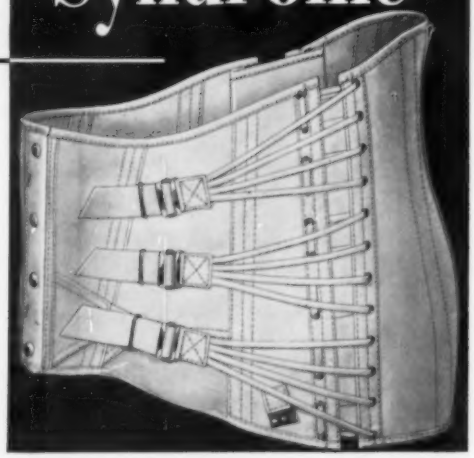

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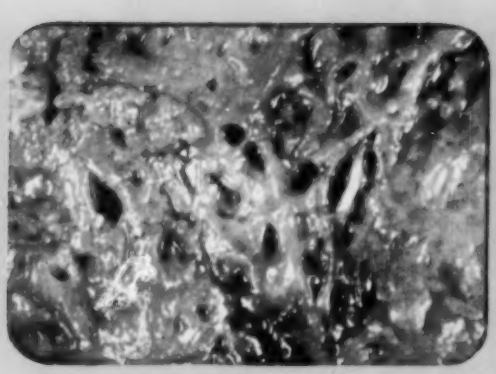

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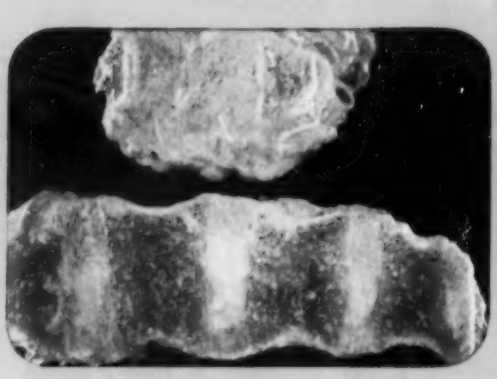

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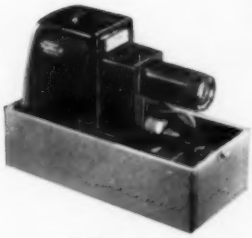

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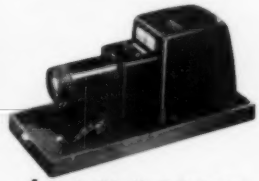

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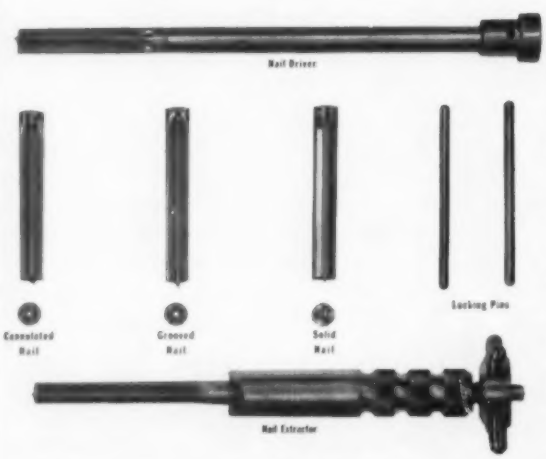

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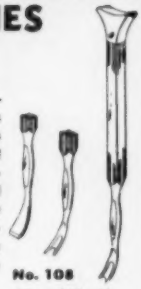

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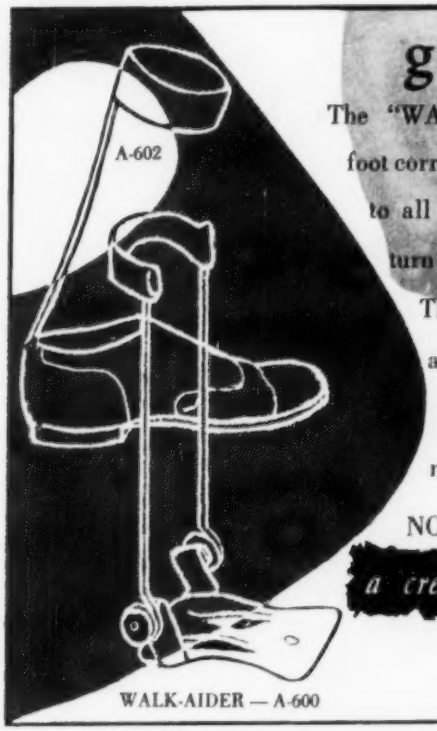

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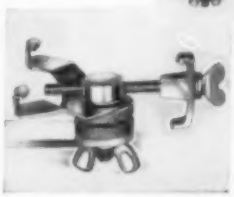

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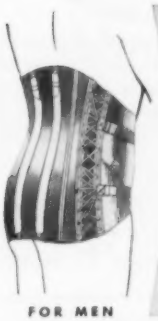

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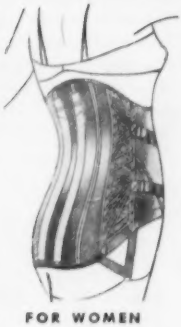

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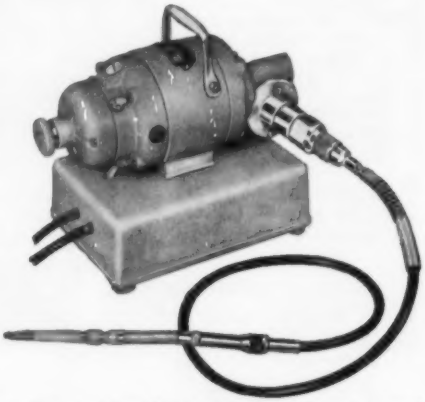

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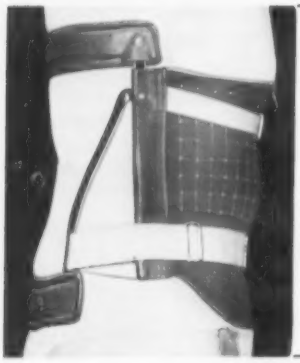

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*Currence, J. D., N. Y. State J. of Med. 48:2044, 1948.
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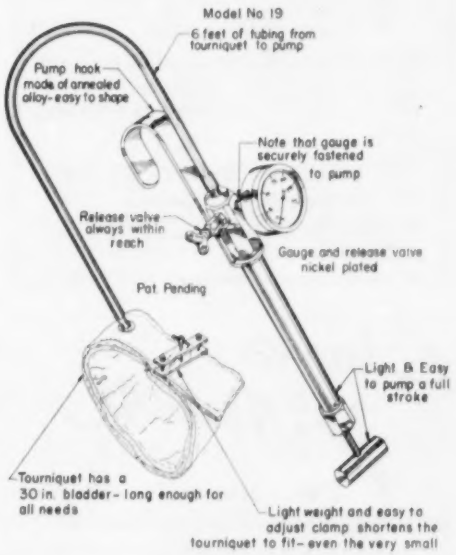
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APRIL 1954

William C. Baird, M.D., 311 Ohio Building, Akron 8, Ohio
Dr. Göran C. H. Bauer, Orthopaedic Clinic, General Hospital, Malmö, Sweden
William H. Bauer, M.D., 3556 Caroline Street, St. Louis 4, Missouri
Harold B. Boyd, M.D., 869 Madison Avenue, Memphis 3, Tennessee
Harold Broder, M.D., 605 Webb Road, Elkins Park 17, Pennsylvania
Bruce M. Cameron, M.D., 5220 Travis, Houston, Texas
Howard L. Cherry, M.D., Standard Insurance Building, Portland 5, Oregon
George J. Garceau, M.D., 23 East Ohio Street, Indianapolis 4, Indiana
Lieutenant Charles F. Gregory, M.C., U.S.N.R., U.S. Naval Hospital, Corona, California
G. Edmund Haggart, M.D., 605 Commonwealth Avenue, Boston 15, Massachusetts
R. H. Hall, M.D., Veterans Administration Hospital, Long Beach, California
Halford Hallock, M.D., 180 Fort Washington Avenue, New York 32, N. Y.
Creighton A. Hardin, M.D., University of Kansas Medical Center, Kansas City 3, Kansas
Alex Harell, M.D., 216 Wall Building, St. Louis 8, Missouri
Captain Henry R. Hume, 3700 U.S.A.F. Hospital, Lackland Air Force Base, San Antonio, Texas
Walter S. Hunt, Jr., M.D., 309 Hillsboro Street, Raleigh, North Carolina
Everett F. Hurteau, M.D., 311 Ohio Building, Akron 8, Ohio
James B. Jones, M.D., 180 Fort Washington Avenue, New York 32, N. Y.
George L. Kraft, M.D., 4418 Vineland, North Hollywood, California
William H. von Lackum, M.D., 654 Madison Avenue, New York 21, N. Y.
Vincent E. Leggiadro, M.D., 461 Westchester Avenue, Port Chester, New York
Baldo Leitner, M.D., Unfallkrankenhaus, Webergasse 2, Vienna XX, Austria
Daniel H. Levinthal, M.D., 501 South Beverly Drive, Beverly Hills, California
Lee W. Milford, M.D., 869 Madison Avenue, Memphis 3, Tennessee
E. J. Moeys, M.D., St. Elisabeth Hospital, Tilburg, Netherlands
George T. Pack, M.D., 139 East Thirty-sixth Street, New York 16, N. Y.
David W. Robinson, M.D., University of Kansas Medical Center, Kansas City 3, Kansas
Ernest Sinclair, M.D., City Hospital, Akron, Ohio
Alan DeForest Smith, M.D., 622 West 168th Street, New York 32, N. Y.
Marcus J. Stewart, M.D., 869 Madison Avenue, Memphis 3, Tennessee
Commander John S. Thiemeyer, Jr., 1509 Magnolia Avenue, Norfolk 8, Virginia
Hugh A. Thompson, M.D., 309 Hillsboro Street, Raleigh, North Carolina
Paul C. Thompson, M.D., Medical Arts Building, Chattanooga 3, Tennessee
O. R. Walker, M.D., The Children's Orthopedic Hospital, 1800 Sand Point Way, Seattle 5, Washington
Anders Westerborn, M.D., Sahlgrenska Sjukhuset, Göteborg, Sweden
Robert Wylie, M.D., 535 Park Avenue, New York 21, N. Y.

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